A Cross-Sectional Examination of the Relationship Between Trait Mindfulness, Behavioral Regulation Toward Exercise, Exercise Intention, Perceived Stress, and Physical Activity in University Undergraduates

by

Vinson Napolitano

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Graduate Supervisory Committee:

Cheryl Der Ananian, Chair
Ann Sebren
Barbara Ainsworth

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ABSTRACT

Physical inactivity is a continuing public health crisis because of its negative effects on health (e.g. hypertension, cardiovascular disease, type II diabetes). To combat the rising prevalence of these non-communicable diseases, physical activity (PA) promotion is a public health priority. However, current programs seem to be ineffective in the long-term promotion of PA. Resultingly new, effective interventions are needed. Recent studies have established a link between mindfulness and PA engagement. Based on the current literature, the present study sought to investigate the associations between trait mindfulness, behavioral regulation towards exercise, exercise intention, stress, and self-reported PA. This study also examined whether trait mindfulness was independently associated with meeting weekly, leisure-time, moderate-to-vigorous PA [MVPA] recommendations in university undergraduate students after controlling for demographic characteristics, past PA experience, exercise intention, stress, and motivation.

The study used a cross-sectional design and participants consisted of 180 undergraduate university students (aged 18 to 24 years). Participants completed a one-time survey that assessed demographic characteristics, trait mindfulness, behavioral regulation toward exercise, exercise intention, perceived stress and PA. Bivariate associations between the variables were assessed with Pearson or Spearman correlations. A logistic regression analysis was conducted to determine which variables were independently associated with meeting weekly, leisure-time MVPA guidelines. Results of this study found weak positive associations between the mindfulness domain of acceptance and leisure time MVPA ($\rho = .168$, $p < .05$), no associations between mindfulness and transportation PA, and negative associations between mindfulness

(MAAS, $\rho = -.238$, $p < .01$; acceptance, $\rho = -.175$, $p < .05$) and sitting time. Results of logistic regression found that only relative autonomy (OR = 1.085, 95% CI [1.008, 1.168], $p = .030$) and intention (OR = 2.193, 95% CI [1.533, 3.138], $p < .0001$) were independently associated with meeting weekly, leisure- time MVPA recommendations. The results of this study show that while there is only a weak direct relationship between trait mindfulness and PA, mindfulness may be related with other factors associated with PA. More research is needed in order to better understand the potential mechanisms behind the results found in this, and past, studies.

DEDICATION

I would first like to express my gratitude to my family who have supported me throughout my time in this program. Ii could always count on you all for a laugh to help me relieve some of the pressure that writing a thesis like this entails. I'd like to thank my friends who have stuck with me through the long periods when all I did was write and write. You all really helped me stay sane and connected throughout this process.

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CHAPTER 1

INTRODUCTION

The transition from high school to university is an important time in an emerging adult's life during which health behaviors may be adopted or abandoned. Data suggest fruit and vegetable consumption and regular participation in physical activity (PA) decline during college years while there is a transient increase in alcohol consumption, binge drinking, smoking (Kwan, Cairney, Faulkner, & Pullenayegum, 2012). According to a systematic review by Engberg et al. (2012), as students transition from high school to college, their PA levels decrease. In a longitudinal study that tracked PA levels from adolescence to early adulthood, Gordon-Larson, Nelson, and Popkin (2004) found that of individuals who participated in five or more days of moderate-to-vigorous PA (MVPA) per week during adolescence, only 31.1% met this criterion during adulthood. More recently, a prospective study that followed high school students until the beginning of their second year at university found significant decreases in PA for both males and females (Deforche, Van Dyck, Deliens, & Bourdeaudhuij, 2015). Moreover, regular participation in PA in college-aged youth is suboptimal. According to the National Center for Health Statistics (2017), 30.7% of 18 to 24-year-olds meet the current national guidelines for both aerobic and muscle-training PA and 34.5% meet the neither the aerobic nor muscle-strengthening guidelines. Furthermore, this trend is also reflected by students at Arizona State University (ASU). According to the American College Health Association (2017), 48% of ASU students met the American College of Sports Medicine Guidelines for aerobic exercise and only 37% performed resistance-training exercises.

Low participation in PA is a public health concern because physical inactivity accounts for 6-10% of all non-communicable diseases and is the fourth principal risk factor for death world-wide (Lee, Shiroma, Lobelo, Puska, Blair, & Katzmarzyk, 2012; Kohl, Craig, Lambert, Inoue, Alkandari, Leetongin, & Kahlmeier, 2012). Participation in regular PA or exercise is associated with decreased mortality and a multitude of beneficial health outcomes such as decreased blood pressure, increased insulin sensitivity, lower risk for cardiovascular disease, and decreased anxiety/depression (Garber et al., 2011). Increasing PA during college has important implications from a primary prevention perspective. While rates of PA participation are sub-optimal for 18 to 24-year-olds, it is well established that participation in PA declines with aging. It is also known that PA behaviors track over time (Morseth et al., 2011). Therefore, increasing PA participation during college may increase the likelihood of long-term PA maintenance if college-aged students can incorporate it into their lifestyle. It may also increase the likelihood of disease prevention if college students begin and maintain an exercise program before any clinical manifestations of disease are present.

Due to the negative health effects of physical inactivity and low adherence to PA guidelines, promoting sustained participation in PA is a priority for many public health institutions, such as the Office of Disease Prevention and Health Promotion, the U.S. Department of Health and Human Services, and the Center of Disease Control and Prevention. While interventions aimed at increasing PA levels are generally effective in the short-term, a meta-analysis conducted in 2016 by Murray, Brennan, French, Paterson, Kee, and Hunter determined interventions targeting long-term changes in PA behavior were less effective. Findings from this meta-analysis suggested the effect of PA

interventions on long-term maintenance of PA (up to 15 months post-intervention) were small (0.20 – 0.28). Moreover, after 15 months post-intervention, there was little evidence of maintained PA.

Because increased levels of PA brought about by interventions tend to diminish over time, there is a need to develop interventions that are effective in helping people initiate and maintain regular PA. While this may seem like a monumental task, one tool that shows promise in the promotion of PA is the psychological construct of mindfulness. Concisely, mindfulness has been defined as "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (Kabat-Zinn, 1994). In other words, the practice of mindfulness is bringing complete attention and non-judgemental acceptance to one's whole experience in the present moment (Kabat-Zinn, 2003).

Although research into the relationship between mindfulness and PA is a new field (it was first investigated in 2007), there have been promising results suggesting positive correlations between mindfulness and PA (Chatzisarantis & Hagger, 2007; Roberts & Danoff-Burg, 2010; Gilbert & Waltz, 2010; Ulmer, Stetson, and Salmon, 2010, Ruffault, Bernier, Juge, & Fournier, 2016). While the mechanisms behind this relationship need to be explored further, there has been some support that intrinsic motivation, intention, and/or stress reductions may be potential explanations. Ruffault et al. (2016) suggest that intrinsic motivation may be a factor. Ruffault et al. (2016) investigated the interplay between motivational regulation toward exercise, how this motivation relates to trait mindfulness, and PA levels. Their findings suggested that higher levels of mindfulness are associated with higher levels of intrinsic motivation and thus increased PA levels. The link between mindfulness, intrinsic motivation, and PA

was further supported by Tsafou, De Ridder, van Ee, and Lacroix (2016) and Tsafou, Lacroix, van Ee, Vinkers, and De Ridder (2017), how found that satisfaction (a key component of intrinsic motivation) mediated the effect of mindfulness on PA. Chatzisarantis and Haggar (2007) found that intentions predicted exercise in more mindful individuals. Roberts and Danoff-burg (2010) concluded that mindfulness is related to decreases stress levels, and this in turn is associated with increased positive health behaviors.

The majority of the research examining the relationship between mindfulness and PA have used cross-sectional or correlational designs. To date, only three published, experimental trials have investigated the relationship between mindfulness and PA. The first, by Salmoirago-Blotcher et al. (2018), found that integrating a school-based mindfulness intervention into high-school health class increased self-reported PA levels. The second, by Cox, Roberts, Cates, and McMahon (2018), found that mindful states during exercise are associated with positive affective responses (increased enjoyment and lower rating of perceived exertion). The final experimental trial, performed by Meyer et al. (2018), found that participation in a Mindfulness-Based Stress Reduction (MBSR) intervention protected against seasonal declines in PA levels. This last study is unique from all the others in that, after a thorough search of the published literature, it was the only study to measure PA levels through use of accelerometry. However, the researchers behind this study did not evaluate trait mindfulness scores and were thus unable to determine if a relationship between objective PA and trait mindfulness exists.

Although there is a growing body of literature to support the relationship between mindfulness and PA, there is still need to investigate the potential mechanisms behind

this relationship further. While the potential mechanisms of behavioral regulation, intention, and reduction of stress have all been investigated individually, there has not yet been and investigation into mindfulness and PA that has included assessments of all these variables. Given the importance influence PA has on health, the need to develop more effective interventions to increase this behavior, and the potential efficacy of utilizing mindfulness-based techniques in aiding this endeavor, it is imperative that we understand the underlying mechanisms behind the relationship between mindfulness and PA in order to build effective interventions.

Purpose, Aims, and Hypotheses

The purpose of this study was to examine the associations between trait mindfulness, behavioral regulation toward exercise, exercise intention, perceived stress and self-reported PA.

Specific Aim 1. To examine associations between trait mindfulness, behavioral regulation towards exercise, exercise intention, perceived stress, and self-reported PA.

Hypothesis 1. There will be a positive association between trait mindfulness and self-reported PA.

Hypothesis 2. There will be a positive association between trait mindfulness and intrinsic regulation towards exercise.

Hypothesis 3. There will be a positive association between trait mindfulness and exercise intention.

Hypothesis 4. There will be a negative association between trait mindfulness and perceived stress.

Specific Aim 2. To examine if trait mindfulness is independently associated with meeting weekly, leisure-time moderate-to-vigorous PA recommendations in university undergraduate students after controlling for demographic characteristics, past PA experience, exercise intention, stress, and motivation.

Hypothesis 1. Trait mindfulness will be independently associated with whether or not university undergraduates meet the minimum recommendations for weekly, leisure-time moderate-to-vigorous PA.

Definition of Terms

1. Behavioral Regulation toward Exercise Questionnaire – Revised (BREQ-II): a subjective self-report measurement instrument based off Deci and Ryan's (1985) Self Determination Theory and used to assess motivation to exercise. Assesses external, introjected, identified, and intrinsic regulations as well as amotivation (Markland & Tobin, 2004).
2. International Physical Activity Questionnaire (IPAQ): a subjective self-report measurement instrument to assess PA and inactivity.
3. Mindfulness (MF): "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (Kabat-Zinn, 1994, p.4). Also defined as bringing complete attention and non-judgmental acceptance to one's whole experience in the present moment (Kabat-Zinn, 2003).
4. Mindful Attention and Awareness Scale (MAAS): a widely used, subjective self-report scale used to measure trait mindfulness. This scale utilized a definition of mindfulness that focuses on present-centered attention and awareness (Brown & Ryan, 2003)
5. Philadelphia Mindfulness Scale (PHLMS): a subjective self-report scale used to measure trait mindfulness and composed of two subscales: present-moment awareness and acceptance (Cardaciotto et al., 2008).
6. Perceived Stress Scale: a subjective self-report scale used to assess the degree to which an individual appraises experiences in their life as stressful (Cohen, Kamarck, & Mermelstein, 11983).

7. Physical Activity (PA): any bodily movement produced by the contraction of skeletal muscles that results in a substantial increase in caloric requirements over resting energy expenditure (Garber et al., 2011).
8. State mindfulness: An active mode of conscious awareness characterized by requiring effort to bring about a state of heightened involvement and wakefulness where an individual is experiencing the present moment and all the events that are occurring (Ivtzan & Hart, 2016).
9. Trait mindfulness: "The degree of day-to-day mindful attention that varies in quality and frequency between individuals" (Brown & Ryan, 2003)

Delimitations

This study will be delimited to all male and female undergraduate students at a large metropolitan Southwestern University.

Limitations.

This study will be a convenience sample of volunteers. All measures of mindfulness are self-reported and participants may not answer all survey items with accuracy. Due to the study sample of university students, results may not be generalizable to the general population. The design of the present study is cross-sectional and thus no inferences of causality can be made.

CHAPTER 2

REVIEW OF LITERATURE

Overview

This chapter describes the need for PA in college populations introduces the construct of mindfulness, its sub-constructs and mechanisms, how mindfulness is measured, the relationship between mindfulness and other health topics, and an exhaustive review of literature relating to mindfulness and PA.

Physical Activity in College Populations

The transition from high school to college life is a period during which emerging adults may adopt or abandon health behaviors including participation in PA. In 2004, Bray and Born compared self-reported vigorous PA from the last two months of high school to self-reported vigorous PA in the first two months at university in a sample of 145 Canadian undergraduate students. Assessing vigorous PA through use of two surveys, the Youth Risk Behavior Survey and the National College Health Risk Behaviors Survey, the Bray and Born found a significant decline [$F(1,144) = 6.88$, $p = .01$] in PA. This decline fell from 3.32 ± 2.12 session per week in the first two months of college to 2.68 ± 2.24 sessions per week in the last two months of their time in college. Although this study is limited by retrospective self-reported PA measures and the fact that it measured only vigorous PA, this trend has been observed in other studies. Gordon-Larson et al. (2004) also investigated the decline in PA seen during the transition from adolescence to adulthood. In this large (n=13,030) longitudinal study, Gordon-Larson et al. assessed MVPA over the course of four years, beginning with the sophomore year of high school and ending during the second year of university. They found that of those

that participated in five or more weekly sessions of MVPA during high school, only 31.1% continued this level of MVPA into adulthood. These findings were further corroborated in a longitudinal study by Small, Bailey-Davis, Morgan, and Maggs in 2013. In this study, self-reported data for fruit, vegetable, and sugar sweetened soda consumption, PA, and sedentary behaviors across seven semesters of college starting with the first semester of the freshman year were analyzed for changes over time. Study findings suggested, consumption of fruits and vegetable dropped from an average of 2.37 servings per day to 1.91 servings per day, soda consumption dropped from an average of 0.58 beverages per day to 0.37 per day, intentional sedentary time decreased from an average of 2.18 hours per day to 1.58 hours per day, and most applicable, the average time of intentional exercise per day decreased from an average of 0.43 hours per day to 0.30 hours per day. Similarly, Kwan, Cairney, Faulkner, and Pullenayegum (2012) investigated various health behaviors over the course of 12 years beginning in 1994 and 1995. Study results indicated that unlike other deleterious health behaviors (e.g. binge drinking and smoking) which decrease or level off as an individual matures, PA over the course of 12 years decreases by 1.54 METs per day in men and 0.59 METs per day in women. While this investigation did not report on PA levels specifically related to the transition from high school to college, it does provide a picture of the decrease seen as individuals age. Finally, Deforche et al. (2015) investigated the changes in weight and body composition and self-reported health behaviors (e.g. PA and sedentary behaviors) during the transition from high school to university. Deforche et al. first measured and assessed 291 Belgium high school students in February of their senior year and then following up with these same measurements 1.5 years later, in the beginning of their

second year of university. To assess PA, the authors used the Flemish Physical Activity Questionnaire to assess minutes per week spent in active transportation and sport participation. Sedentary behaviors were assessed using the Sedentary Behaviors Questionnaire which assesses minutes per day spent participating in behaviors such as watching TV, internet use, studying, etc. Results of this study found a decrease in active transportation from 337 ± 217 to 224 ± 141 minutes per week in males, and from 287 ± 188 to 212 ± 124 minutes per week in females. Sport participation dropped from 241 ± 239 to 138 ± 183 minutes per week for males, and 158 ± 201 to 98 ± 137 minutes per week in females. Significant increases in sedentary behaviors included: internet use not for school (66.8 ± 48.6 to 89.8 ± 56.1 minutes per day for males, 78.3 ± 57.2 to 91.9 ± 60.1 minutes per day for females, $p < .001$), studying (84.2 ± 54.9 to 114.5 ± 65.6 minutes per day for males, 123.0 ± 55.5 to 144.0 ± 56.4 minutes per day for females, $p < .001$), and sitting while talking with friends or family (69.2 ± 54.7 to 84.8 ± 61.3 minutes per day for males, 91.1 ± 62.9 to 99.4 ± 62.6 minutes per day for females, $p = .01$).

This decline in PA during young adulthood is concerning for a multitude of reasons. Physical inactivity has been found to account for 6% to 10% of all non-communicable disease and is the fourth highest risk factor for death worldwide (Lee et al., 2012; Kohl, Craig et al., 2012). While the majority of diagnosis of non-communicable diseases occurs during middle age (45-64), there is data to support the growing prevalence of risk factors for diseases such as type 2 diabetes and cardiovascular disease in college-aged populations. In 2011, Frenandes and Lofgren examined the prevalence of metabolic syndrome and individual criteria for metabolic syndrome in 189 American college students. While only 3.7% of the study participants met the criteria for

metabolic syndrome, 28.0% and 7.4% of the sample presented with one or two criteria for metabolic syndrome, respectively. The two most common risk factors identified were low concentrations of HDL cholesterol and elevated triacylglycerols. Similarly, in a study investigating cardiovascular risk factors in 158 American college students, Tran et al. (2017) found that over half of the participants presented with one or more modifiable cardiovascular disease risk factors: 36.1% had one risk factor, 13.9% had two risk factors, and 2.5% had three risk factors. The two most common risk factors identified were being overweight or obese (44.9%) and elevated blood pressure (12.7%). While the prevalence of the aforementioned risk factors is relatively low in comparison to the general population and these risk factors have not yet presented as clinical disease, it is evident there is a need to encourage behavior modification (such as increasing participation in PA) in order to combat the development of non-communicable diseases such and cardiovascular disease and type 2 diabetes. While increasing PA can be a difficult endeavor, there is promising research to support the use of mindfulness-based interventions to aid in the modification of healthy behaviors, such as participation in PA (Tapper et al., 2009; Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011; Kangasniemi, Lappalainen, Kankaanpää, Tolvanen, & Tammelin, 2015; Cox et al., 2018; Meyer et al., 2018).

What is Mindfulness?

Mindfulness is a practice derived from traditional Buddhist teachings, it has been in existence for millennia. Though this practice has been around since antiquity, it was introduced and adapted for the Western world during the late 20th Century. Dr. Jon Kabat-Zinn played a pivotal role in this when, in 1979, he developed and introduced an

intervention known as Mindfulness-Based Stress Reduction (Kabet-Zinn, 2003). This was one of the first uses of mindfulness-based techniques in the West to aid in behavior modification. Succinctly, mindfulness is defined as complete attention and non-judgmental acceptance of one's whole experience in the present moment (Kabat-Zinn, 2003; Baer, 2004). Perhaps due to the relative newness of the field of study or the complexity of the subject, there has not yet been a single definition or model used to explain the intricacies of mindfulness, nor can the full scope of the field be summarized in a single sentence. To that end, this review of the literature will seek to synthesize a working definition from a multitude of sources.

Exploring the definition. Two key elements discussed in the definition of mindfulness are self-regulation of attention and a non-judgmental orientation toward experience (Bishop et al, 2004). According to Cardaciotto et al. (2008), attention can be defined as "a heightened sensitivity to a restricted range of experience" (p. 205). Specifically, mindfulness involves attending to present moment experience, including bodily sensations, feelings, emotions, thoughts, and perceptions (Baer, 2003; Creswell, 2017). The second component of mindfulness, non-judgmental acceptance, is objective observation of one's own thoughts, emotions, feelings, and bodily sensations in such a way that while there is careful attention placed upon them, one does not attach a value (good or bad, positive or negative, etc.) to that experience (Baer, 2003). In other words, openness and acceptance in mindfulness rests on a curious, inviting, and non-reactive attitude toward experience (Creswell, 2017).

The earliest applications of mindfulness in health-based practices in the West centered on acceptance of chronic pain. Early studies demonstrated mindfulness is

effective in helping individuals cope with painful or uncomfortable experiences (Kabat-Zinn, 2003). Carlson (2015) suggested that one possible mechanism behind this increased ability to cope with pain and discomfort could be that learning to respond to these experiences with mindfulness, rather than aversion, leads to acceptance, relaxation, and ultimately attenuation of said pain/discomfort. In subsequent sections, this and other mechanisms will be introduced that may explain the relationship between mindfulness and PA.

State and trait mindfulness. The literature describes mindfulness in two measurable ways: either as a mindful state or as a trait. Ivtzan and Hart (2016) conceptualize state mindfulness as an active mode of conscious awareness characterized by requiring effort to bring about a state of heightened involvement and wakefulness in which an individual experiences the present moment and all internal and external events that are occurring. Mindful states result through the practice of mindful meditation and, with repeated practice, are shown to increase the exhibition of mindfulness in daily life (Kiken, Garland, Bluth, Palsson, & Gaylord, 2014). This everyday mindfulness is otherwise known as trait, or dispositional, mindfulness. Brown and Ryan's (2003) definition of dispositional mindfulness is "the degree of day-to-day mindful attention that varies in quality and frequency between individuals." This brief description of some of the concepts of mindfulness will lay the groundwork for the following sections and their relation to health behaviors, namely PA.

Measurement of mindfulness. As with other psychological constructs, mindfulness is measured through self-report questionnaires. Just as the definition of mindfulness varies from author to author, so too do the questionnaires that measure

mindfulness. Currently, there is no "gold standard" of measurement when it comes to mindfulness. While there are multiple questionnaires, surveys, and scales that measure both state and trait mindfulness, only three are pertinent to the purposes of this study.

State mindfulness measurements. Measurement of state mindfulness attempts to elucidate mindfulness as a context dependent mental behavior that occurs during the moment of question (Tanay & Bernstein, 2013). The State Mindfulness Scale for PA (SAS-PA; Cox, Ullrich and French, 2015) is an adapted and validated version of the State Mindfulness Scale (SAS) for measuring state mindfulness during PA. However, the adaptations were only validated for administration during exercise. While use of the SAS-PA would be a clear choice during an experimental study in which a mindful state is induced during a bout of PA, for the purposes of the present study, its use would be inappropriate.

Trait mindfulness measurements. The Mindful Attention and Awareness Scale (MAAS) and the Philadelphia Mindfulness Scale (PHLMS) both measure trait mindfulness and are applicable to this study. The MAAS was developed by Brown and Ryan (2003) to identify and measure inter- and intrapersonal variations in mindfulness and to establish these variations with other psychological constructs. Brown and Ryan (2003) define mindfulness as "the state of being attentive to and aware of what is taking place in the present" (p. 822). Furthermore, they break this definition down further to describe awareness as continual monitoring of the external and internal environments, and attention as the process of focusing awareness in order to provide increased sensitivity to a limited range of experience. According to Qu et al. (2015), who assessed 8 different mindfulness measurement tools, the MAAS is the most widely used throughout

the literature, being cited by 3545 articles. The widespread use of the MAAS was one of the reasons that this scale was included in the present study. Further reasons for the inclusion of this measurement tool were the fact that the authors have a clear operational definition of mindfulness, has evidence of high reliability and validity (Qu et al., 2015), and provides a global mindfulness score. This last point can also be considered one of the limitations of the MAAS as acceptance and awareness, while both included in the definition of mindfulness, are two separate components of consciousness (Van Dam, Earleywine, & Borders, 2010).

The second questionnaire we will use in the present study to measure trait mindfulness is the Philadelphia Mindfulness Scale. This scale was developed by Cardaciotto, Herbert, Forman, Moitra, and Farrow in 2008 in order to measure mindfulness in populations without meditation experience. The scale was designed to separately assess the mindfulness concepts of 'acceptance' and 'awareness'. In order to do so, the authors conceptualized mindfulness as "the tendency to be highly aware of one's internal and external experiences in the context of an accepting, nonjudgmental stance toward those experiences" (p. 205). Building off this conceptualization, Cardaciotto et al. (2008) define the first component of their scale, awareness, as a "continuous monitoring of experience with a focus on current experience rather than preoccupation with the past or future events" (p. 205). The second component, acceptance, is defined as "experiencing events fully and without defense, as they are, during which one is open to the reality of the present moment without being in state of belief or disbelief" (p. 205). The PHLMS, while not widely used in the literature regarding mindfulness and PA, was selected for the present study for multiple reasons.

First of all, the validity and reliability of the PHLMS has been evaluated in multiple studies and has been found to be a satisfactory instrument for use in measuring trait mindfulness (Cardaciotto et al., 2009; Qu, Dasborough, & Todorova, 2015; Andrei, Vesely, & Siegling, 2016). Secondly, the PHLMS was developed specifically for use in populations without meditation experience. Gilbert and Waltz (2010) demonstrated that only 13.5% of undergraduate students participate in meditation practice so the majority of our study participants will likely not engage in meditation. Finally, the PHLMS was chosen because its conceptualization of mindfulness aligns with that used in the present study. This instrument is not without its limitations, however. First, the authors note that all items pertaining to the subscale of Acceptance are reverse scored, thereby being an indirect, rather than direct, assessment of Acceptance. Second, though they support the use of the PHLMS, Andrei et al. (2016), state that the PHLMS is more appropriate when assessing the distinct dimensions of mindfulness as it does not include one total score of global mindfulness.

Mindfulness and Health Behaviors

Mindfulness-based stress reduction. Since its introduction to the clinical field, the effects of mindfulness have been studied in conjunction with various health behaviors. The initial research investigating mindfulness-based interventions and health behaviors began with Jon Kabat-Zinn with his Mindfulness-Based Stress Reduction (MBSR) program which targeted the management of stress in individuals with chronic pain (Kabat-Zinn, 1982). Stress is a public health concern because it has been linked to negative physical and mental health outcomes such as depression, anxiety, and

cardiovascular disease (Sharma & Rush, 2014). Stress is also known to disrupt other health behaviors such as smoking, diet, and PA (Creswell, 2017).

While MBSR was initially introduced to treat clinical populations, these programs have also been introduced to healthy, non-clinical populations and have been demonstrated to result in positive health outcomes for these populations as well. In fact, Khoury, Sharma, Rush, and Fournier (2015) recently conducted a meta-analysis examining the effects of mindfulness-based stress reduction interventions on psychological outcomes (i.e. stress, distress, anxiety, depression, and burnout) in populations ranging from undergraduate students to medical professionals. The objectives of this meta-analysis were to quantify the effect size of MBSR programs for the aforementioned psychological variables, to determine and quantify what role mindfulness plays in said programs, and to elucidate any moderating variables. This meta-analysis included 29 studies (10 of which included student populations) and included 2668 participants. Khoury et al. found moderate effect sizes for both studies that included a within-group (n = 26; Hedge's g = .55; 95% CI [.44, .66], p < .00001) design as well as a between groups (n = 18; Hedge's g = .53; 95% CI [.41, .64], p < .00001) design. It is important to note that these overall effect sizes included populations that were highly and moderately heterogeneous, respectively. Studies that included populations similar to that of the present study (students) also demonstrated similar, albeit slightly smaller, effect sizes both within-groups (n = 10; Hedge's g = .42; 95% CI [.29, .55], p < .00001) and between-groups (n = *9*; Hedge's g = .47; 95% CI [.30, .64], p < .00001). These results suggest that even in non-clinical populations, mindfulness training can be an effective means of reducing stress and increasing quality of life.

Mindfulness and smoking cessation. The effects of mindfulness on smoking cessation is a newer area of exploration. As such, there are fewer studies examining the effectiveness of mindfulness-based interventions smoking cessation. To date, only two meta-analyses have been published on the topic, both of which were published in the year 2017 and included the most recent research on mindfulness and smoking cessation. The first meta-analysis, by Maglione et al. (2017), included only RCTs of adults, that reported tobacco use cessation or reduction of use, that utilized mindfulness training either by itself or in conjunction with other types of intervention, and excluded studies that contained types of meditation other than mindfulness (e.g. tai chi, yoga, qigong, etc.). Studies included in this analysis contained a variety of control groups (i.e. treatment as usual, waitlist control, no treatment, or other active treatments). Overall, the meta-analysis contained 10 RCTs that included 1192 participants with mean ages ranging from 21.5 years to 46.9 years. To determine the efficacy of mindfulness meditation interventions, the authors conducted a series of meta-analyses on the six studies that reported the number of participants that had succeeded in smoking cessation. After excluding a study whose participants presented with mild intellectual disabilities, the authors report a trend favoring mindfulness meditation on smoking cessation at the longterm follow up (17 to 24 weeks). This trend, however, was not statistically significant and the authors report no statistical difference between the meditation and comparison groups (OR 1.87; 95 % CI [0.81, 4.32]; 5 RCTs I^2 32.3%). The remaining four RCTs reported the number of cigarettes per day at baseline and follow up. Results from these studies, while not statistically significant, again favored mindfulness meditation over comparison groups (weighted mean difference = 1.52; 95% CI [-1.03,

4.07]; 4 RCTs; I^2 16%). The authors also noted that the weighted mean difference of 1.5 is not of clinical significance.

Oikonomou, Arvanitis, and Sokolove (2017) also conducted a meta-analysis to determine the efficacy of mindfulness training in smoking cessation. This meta-analysis differed from that of Maglione et al. (2017) in that Oikonomou et al. (2017) had more stringent eligibility criteria. Notably, Oikonomou et al. included only the studies that utilized mindfulness as a stand-alone treatment and excluded any studies in which smoking abstinence rates were not verified biochemically. Overall, this meta-analysis included 4 studies containing 474 participants. The authors of this analysis found that while there was no difference in short-term (4-6 weeks) smoking abstinence, individuals who received mindfulness interventions had significantly greater long-term (17-24 weeks) abstinence rates compared to the comparison groups (RR, 1.88; 95% CI [1.04, 3.40]). Due to trait mindfulness (as measured by the Five Facets of Mindfulness Quesstionnaire) being reported in two of the studies, the authors were also able to analyze the changes in trait mindfulness in the intervention and control groups. They found a significant change in global trait mindfulness at 4 weeks (p=0.042; SMD=0.376) and 24 weeks (p=0.013; SMD=0.458) in the mindfulness groups compared to the control groups.

Mindfulness and eating behavior. While still a relatively new field of study, compared to the research regarding mindfulness and smoking cessation or PA, there has been a fairly robust investigation into the effects that mindfulness-based techniques have on eating behaviors, such as restrictive or emotional eating, especially in clinical populations. Godfrey, Gallo, and Afari (2014) recognized that the use of MBIs to treat binge eating disorder (BED) but noted that the effects of these interventions had not been

investigated in depth. As a result of this, they performed a systematic review and meta-analysis that included 19 studies that included various mindfulness-based therapies (e.g. dialectical behavioral therapy or acceptance and commitment therapy) and included assessments of binge eating as an outcome. While the authors note that their analysis was limited by heterogeneity among studies, they reported a large within-group effect size (mean Hedge's g = -1.12, 95 % CI -1.67, -0.80, k = 18) and a medium-large between group effect size (mean Hedge's g = -0.70, 95 % CI -1.16, -0.24, k = 7) in support for the efficacy of MBIs in reducing binge eating behaviors. However, they do note that the effect sizes were smaller for studies that included participants with lower amounts of binge eating behaviors (Godfrey et al., 2014).

Further investigation into the effects of MBIs on eating behaviors was conducted by Rogers, Ferrari, Mosely, Lang, and Brennan (2016) who evaluated the impact of MBIs on physical and psychological health outcomes in adults with overweight or obesity. A total of 15 studies were found to fit their inclusion criteria that the participants must be overweight or obese adults, the studies must have utilized acceptance or mindfulness-based interventions as their main treatment, and the treatment had to have included more than one session. The results of their analysis found that participants across the 15 studies lost an average of 4.2 kg after treatment, having a small effect size for BMI (g = 0.47; 95% CI: 0.30–0.65). They also found a large effect size for improving eating behaviors (g = 1.08; 95% CI:0.32–1.84) and a medium effect size for improving eating attitudes (g = 0.57; 95% CI: 0.40–0.74). While there were some limitation present in this analysis (such as the quality of studies included, small amount of studies that included control groups, or

variability of outcome measures), the results of Rogers et al. (2016) support the use of MBIs as a treatment for eating behaviors related to overweight and obesity.

One final meta-analysis that investigated the use of mindfulness-based programs for the prevention of editing disorders was conducted in 2018 by Beccia, Dunlap, Hanes, Courneene, and Zwickey. To be included in this meta-analysis studies must have included: an RCT, a clustered RCT, controlled before-and-after design, or pre-post design; its purpose must have been the promotion of protective factors or reduction of risk factors associated with EDs; contained at least one standardized psychological measure; included "high-risk" participants with no known history of history of an ED diagnosis; and to have included a mindfulness-based component (though they used a very broad interpretation of mindfulness). Overall, Beccia et al. (2018) included 20 studies with a total of 2173 participants. Eleven of these studies included college-aged participants (18 to 24 years old). They found that when compared to control groups, participants that went through a mindfulness-based program had decreased body image concern (SMD = −0.26, 95% CI: −0.49 to −0.03), decreased negative affect (SMD = −0.28, 95% CI: −0.51 to −0.05), higher body appreciation (SMD = 0.64, 95% CI: 0.38–0.90), and increased self-esteem (SMD = 0.80, 95% CI: 0.37–1.22). There were several limitations present in this meta-analysis: there was potential attrition bias, most of the studies used a selective prevention program as opposed to a universal program (limiting the applicability to community-based public health programs), and that use of a waitlist control group in some of the studies could have moderated the intervention effects due to motivation and/or expectancy. Despite these limitations, Beccia et al. (2018) found strong

support that mindfulness-based interventions have large potential for the prevention of eating disorders.

While the first two meta-analyses included clinical populations and found promising results, the benefits of a mindfulness-based interventions for the improvement of eating behaviors also seen in relatively healthy populations as well. For example, in 2012 Alberts and Raes addressed the efficacy of an 8-week mindfulness-based intervention (MBCT) on correlates of disordered eating behaviors, specifically BMI, eating behaviors, cravings, dichotomous thinking and body image concern. Their wait-list RCT included a total of 26 participants who, while not diagnosed with a clinical eating disorder, presented with one or more of four types of problematic eating (i.e. emotional eating (EE), stress-related eating, eating without awareness, and/or overeating). They found multiple significant differences between the intervention and waitlist control groups, including: an increase in trait mindfulness, a decreased amount of external eating, less body image concern, less dichotomous thinking, and a decline in food cravings.

In a cross-sectional study of 157 nonclinical participants, Pidgeon, Lacota, and Champion (2013) investigated mindfulness as a moderating factor in the relationship between psychological distress and emotional eating. They found that higher trait mindfulness (MAAS) shared a positive association with general nutrition knowledge, lower levels of depression, anxiety and stress, and a smaller likelihood for engaging in emotional eating. The authors also reported that trait mindfulness moderated the relationship between emotional eating and psychological distress, such that when psychological distress levels were low, higher mindfulness was associated with less

emotional eating. This moderating effect seemed to decrease as psychological distress increased.

Corsica, Hood, Katterman, Kleinman, and Ivan (2013), in a 6-week RCT, compared the effects a MBSR intervention, a tailored cognitive-behavioral stress eating intervention (SEI), and a combination (MBSR + SEI) intervention on perceived stress levels, stress and emotional eating, and body weight for 53 non-clinical individuals who had difficulty with binge eating, emotional/stress eating, intense or irresistible food cravings, or food addiction. They found that over the course of the intervention and at a 12-week follow up, all three groups showed large improvements in both perceived stress and stress eating, with the combination group showing the most improvement. They also reported moderate, non-significant weight loss in both the SEI and combination groups.

In their 2014 study, Jenkins and Tapper sought to examine "the effects of two mindfulness-based strategies on chocolate consumption amongst individuals who were trying to reduce the amount of chocolate consumed" (Jenkins & Tapper, 2014) by allocated 137 participants into one of three groups: a cognitive defusion group, an acceptance group, or a relaxation control group. While they found no difference between the control and acceptance groups for the amount of chocolate consumed, they did find that those allocated to the cognitive defusion group objectively ate significantly less chocolate and that these differences were driven by a reduction in automatic chocolate consumption. They also noted that lower levels of automaticity were associated with lower levels of chocolate consumption.

In a two-part study, Levoy, Lazaridou, Brewer, and Fulwiler (2016) explored the effects of am MBSR program on emotional eating in the general population (n = 332) and

whether changes in trait mindfulness could predict changes in emotional eating. Their first study, a single-group pretest-posttest design, found a significant decrease in EE scores following the intervention with higher EE scores at baselines showing greatest improvement following the intervention. In the second part of their study, Levoy et al. expanded on the results of their first study by having a total of 117 participants complete online surveys assessing emotional eating, trait mindfulness, and perceived stress pre- and post-intervention. They again found a significant decrease in emotional eating following the completion of the MBSR program. Furthermore, they found that change in total trait mindfulness (measured by the Five Facets of Mindfulness Questionnaire) predicted changes in emotional eating. They do note that, when factoring in changes in perceived stress, this relationship became nonsignificant.

Mindfulness and physical activity. As with the previously mentioned health behaviors, the research investigating the relationship between mindfulness and PA is a new field of study. In fact, Chatzisarantis and Haggar conducted the first study to examine PA in the context of mindfulness in 2007. To do so, the authors conducted a two-part, cross-sectional study in order to examine the moderating effects of MF in the context of physical exercise with a secondary objective of determining if mindfulness was a factor in the preservation of participants' intentions to participate in PA against counter-intentional habits, in this case binge-drinking behaviors.

To do this, Chatzisarantis and Haggar first provided 226 university students (51.3% female, mean age 19.23 ± 1.08) with a definition of vigorous intensity PA as "leisure-time activities performed at a vigorous intensity for at least 40 min at a time, 4 days per week, during the next 5 weeks" (Chatzisarantis & Hagger, 2007, p. 666). After

confirming that the participants understood this definition, the participants completed a questionnaire assessing subjective norms, perceived controllability of PA, habit, and mindfulness. Five weeks after the initial data collection, the participants were again provided with the definition of vigorous intensity PA and self-reported activity levels were assessed. The authors reported, in accordance with previous research, there was a positive correlation between intentions and self-reported PA behaviors (r=0.41, p<0.05) as well as a positive association between intentions and perceived behavioral control (r=0.24, p<0.05), attitudes (r=0.45, p<0.05), subjective norms (r=0.20, p<0.05), and habit (r=0.85, p<0.05) (Chatzisarantis & Hagger, 2007). Mindfulness was correlated with attitudes and perceived behavioral control but it was not associated with PA behavior, habit, or intentions. These findings suggest that mindfulness has an indirect relationship with PA. In fact, after performing a regression analysis, the authors concluded that, based on their findings, mindfulness was a moderator for the intention-behavior relationship in that intentions only predicted PA in those that that acted mindfully and that it did not for those not acting mindfully (Chatzisarantis & Hagger, 2007).

The second part of this study investigated the protective effects of mindfulness on PA behaviors from counter-intentional binge-drinking habits by repeating the protocols of the first study for 292 participants (51.3% female, mean age 19.48 ± 1.23) and added measuring variables for binge drinking. They found that binge drinking was negatively associated with PA intentions (r=-0.14, p<0.05) and that mindfulness was positively associated with attitudes (r=0.16, p<0.05) and perceived control (r=0.21, p<0.05) (Chatzisarantis & Hagger, 2007). The authors conclude from these findings that, overall,

the results of this second half of the study support mindfulness as a protector for behaviors because they can exercise control over counter-intentional habits.

Though the main purpose of this study was to investigate mindfulness in the context of the Theory of Planned Behavior, it is the first to link PA behaviors and mindfulness. It also provides a possible pathway that could explain this association; this pathway is through the intention-behavior relationship. The authors speculate that the increased awareness and attention to internal experiences and environmental influences that characterizes individuals that are more mindful facilitates a successful translation of intentions to actions by strengthening an individual's ability for self-control (Chatzisarantis & Hagger, 2007). In other words, having a mindful mindset allows individuals to fulfill their intentions by staying focused on their goal while being able to control counter-intentional thoughts. These conclusions seem to agree with Shapiro, Carlson, Astin, and Freedman's (2006) theory of mindfulness mechanisms, which speculates that two of the ways in which mindfulness can influence behaviors is through values clarification and self-regulation. Essentially, the practice of mindfulness enables individuals to determine what is truly meaningful to them and make decisions in accordance with these goals. Self-regulation is one of the mechanisms that can aid in this in that self-regulation allows individuals to interrupt habits and to act in ways that agree with health (e.g. PA participation) goals.

While a groundbreaking study, it is not without limitations. The first limitation of this study was how PA levels were measured. The authors of this article provided only part of Godin and Shepard's (1985) instrument. While the full questionnaire contains questions about mild, moderate, and intense PA, Chatzisarantis and Haggar (2007) used

only the definition of vigorous PA for their study. This may have limited their study by underreporting the amount of PA that their participants engaged in. that was developed in. A second limitation of this study is the homogeneity of the participant population. The sample used in this article was drawn from university students and while this is similar to the sample of the present project, Chatzisarantis and Haggar's results may not translate to the greater population.

In one of three studies published in regarding the relationship of mindfulness and PA behaviors, Roberts and Danoff-Burg explored the relationships among mindfulness and health behaviors of college students and were especially interested in the role that stress played in the mediation of these effects. This study included 553 college-aged participants (69.5% female, mean age of 18.8 ± 2.1 years). After providing informed consent, the participants completed questionnaires aimed at assessing, among other variables, PA, mindfulness, and stress. The Youth Risk Behavior Surveillance System was used to assess how many days in the past week participants were active for 60 minutes or more. The Weight and Lifestyle Inventory was used to assess daily activity level (on a 1 to 10 scale ranging from very sedentary to very active) and the extent to which they enjoy PA (on a scale ranging from 1, "not at all," to 4, "greatly"). Trait mindfulness was assessed with the FFMQ, and stress was assessed with the Short-Form Perceived Stress Scale.

Bivariate correlations were used to examine relationships between mindfulness and PA. Results from this study indicated mindfulness was negatively associated with higher stress (r=-.514, p < .001) and positively associated with self-reported weekly PA (r=.087, p < .05), PA enjoyment (r=.146, p < .01), and self-reported daily PA levels

(r=.175, p < .001). Mediation analyses examined stress as a mediating variable between mindfulness and PA. Roberts and Danoff-Burg (2010) state that their findings suggest that stress partially mediates the relationship between mindfulness and PA. These results would suggest that higher mindfulness is related to less perceived stress and this, in turn, contributes to better health behaviors.

The study by Roberst and Danoff-Burg (2010) is limited in several ways. First, due to the cross-sectional design of the study, no inferences can be made about causality. Second, the sample used in this study was homogenous (mostly Caucasian, college-aged, educated individuals) and thus results have limited generalizability. The authors also state that due to the large sample size, there is potential that this caused statistically significant results when there should not be any. Fourth, they state that the FFMQ is limited in its ability to measure mindfulness in relation to health behaviors. One final limitation that present in this study stems from the mediation analysis performed. In 2003, Cole and Maxwell concluded that a mediation analysis requires longitudinal data with a minimum of two time points in order to help determine a casual pathway. Roberts and Danoff-Burg collected data at only one point, thereby not satisfying the temporal sequencing required to make causal inferences and limiting the conclusions of their study.

Despite these limitations, Roberts and Danoff-Burg's findings suggest that a relationship between mindfulness and self-reported PA, does indeed exist and attempted to explain how this may be so. Although causation cannot be implied from this study, it does lay the groundwork for future investigation into one of the potential mechanisms behind the influence of mindfulness on PA. This study was one of the earliest attempts to

explain why this relationship exists. Based on previous research, the researchers postulate higher trait mindfulness is associated with decreased stress levels and this, in turn, contributes to increased positive health perceptions and behaviors. The authors elaborate on this further by suggesting a reduction in tension (i.e. relaxation) is a key mechanism behind mindfulness' positive effects. This reduction in stress is a result of higher levels of non-attachment (viewing happiness as independent from external situations), increased emotional regulation (managing negative emotions), and decreased rumination (repeated engagement of negative, self-focused thoughts).

While the previous study focused on stress as one of the potential mechanisms to explain the relationship between MF and PA, Gilbert and Waltz (2010) took a slightly different approach. They were interested in examining if mindfulness had a relationship with not only the participation in PA, but also with exercise self-efficacy. Additionally, they wanted to parse out which aspects of mindfulness had the greatest correlation with the aforementioned outcomes. In order to investigate this, Gilbert and Waltz performed a cross-sectional study with 269 participants (68.8% female, mean age = 20.9 years, 96% Caucasian, and with 13.5% engaging in meditation practice) from a Western university. To measure PA, the authors used the International Physical Activity Questionnaire (IPAQ). The IPAQ has been deemed one of the more reliable survey instruments for self-reported PA data in 2010 by Van Poppel et al. in their meta-analysis of various PA questionnaires. To measure exercise self-efficacy, Gilbert and Waltz used the Exercise Confidence Survey. The authors used the Five Facets of Mindfulness Questionnaire (FFMQ) to measure trait mindfulness. The FFMQ (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) measures five facets of mindfulness: non-react, observe, non-judge, act

with awareness and describe (Baer et al.,2006; Smith, Hopkins, Krietemeyer, & Toney, 2006; Roberts and Danoff-Burg, 2010; Gilbert & Waltz, 2010).

Due to gender differences found in an examination of study variables, Gilbert and Waltz conducted separate stepwise regression analyses for males and females. For males, the authors found that the Observe subscale alone was predictive for moderate PA (R^2=0.07, β=0.26, p<.05), vigorous PA (R^2=0.05, β=0.22, p<.05), and self-efficacy for making time to exercise (R^2=0.08, β=0.42, p<.01). Additionally, in males they also found that (in conjunction with the Nonjudge subscale [R^2=0.23, β=0.26, p<.01]) the Observe subscale was also predictive for self-efficacy to resist exercise relapse (R^2=0.23, β=0.42, p<.01). For females, the findings suggested the Describe subscale alone predicted moderate PA (R^2=0.03, β=0.17, p<.05) and self-efficacy for making time to exercise (R^2=0.04, β=0.20, p<.01). When the associations of the Describe subscale (R^2=0.09, β=0.23, p<.01) and the Nonreact subscale (R^2=0.09, β=0.15, p<.01) were combined, these facets of mindfulness predicted self-efficacy for resisting exercise relapse in females. For females, the Act with Awareness subscale predicted vigorous PA (R^2=0.03, β=0.17, p<.05). The Describe subscale was not significant for male and the Nonjudge subscale was not significant for females.

Findings from the study by Gilbert and Waltz (2010) suggest higher levels of mindfulness are related to higher levels of PA and exercise self-efficacy. However, when considering these conclusions, it would be wise to stay aware that the associations found in this study were rather weak. One potential mechanism explaining this relationship is increased mindfulness may lead to greater self-regulation and self-control, allowing individuals higher in mindfulness to better monitor and regulate their engagement in

healthy behaviors (such as being physically active). As reported in the results above, the Observe subscale (noticing and being aware of bodily sensations and the interplay between this, emotions, feelings, and behaviors) was the most important for males and the Describe subscale (stepping back to observe thoughts, feelings, and emotions then putting this into words) was most important for healthy behavior in females. These subscales in particular may be more indicative of health behaviors because both the Observe and Describe subscales involve the cognitive ability to monitor one's experiences, which has been referred to as decentered awareness or reperceiving. According to Shapiro et al. (2006), this process of decentering is a shift in perspective that allows one to take a step back and dis-identify with thoughts, emotions, and feelings, enabling one to experience these internal events with greater objectivity and clearness. So, rather than being controlled or defined by internal experiences, one can objectively (non-judgmentally) observe and label them. According to Shapiro et al.'s (2006) theory, reperceiving is the meta-mechanism that leads to the additional mechanisms (i.e. self-regulation, psychological flexibility, and exposure) that can contribute to behavioral changes that lead to improved health and well-being.

Gilbert and Waltz's (2010) study is limited in several ways. First, the authors point out that the benefits of mindfulness are different for those who practice mediation and those who do not (such as the majority of the participants in this study), thereby underestimating the potential benefits of mindfulness. Second, the college students who participated in this study were very homogenous, limiting the external validity of this study. Thirdly, Gilbert and Waltz used the FFMQ to measure trait mindfulness because they were interested in how the various facets of this scale related to PA. However, as

reported earlier in this literature review, the Observe facet of the FFMQ may not be valid for those participants who do not have prior mindfulness meditation experience. Lastly, as previously mentioned, the associations between mindfulness, PA, and exercise self-efficacy that Gilbert and Waltz found as a result of their investigation were very weak and thus more investigation into these relationships should be performed.

The three previous studies investigated the how mindfulness relates to the amount of PA the participants performed. Ulmer, Stetson, and Salmon (2010) took a different approach and investigated the influence of mindfulness, acceptance, and suppression on exercise initiation and maintenance. The researchers hypothesized the negative aspects of the "lived" exercise experience (e.g. the pain, discomfort, soreness, low self-efficacy) are factors that account for low adherence to and maintenance of PA guidelines. Ulmer et al. (2010) make the argument that because mindfulness- and acceptance-based interventions, such as MBSR, have been successful in helping participants deal with chronic unpleasant or painful experiences, then application of mindfulness techniques to exercise may work in a similar fashion. The authors specifically postulate, "the model predicts sensations associated with exercise initiation and maintenance - some of which are inevitably unpleasant or even painful - would elicit balanced appraisals of experiences that might otherwise lead to avoidant or suppressive behaviors" (Ulmer et al., 2010, p.806). In order to test this model in the context of exercise, Ulmer et al. surveyed 226 YMCA members from Kentucky and Louisiana (mean age = 49.96 ± 14.73, 85,8% Caucasian, and 65% female). Measurement of the variables of interest to this study was obtained via a survey. The authors developed an exercise status questionnaire to determine exercise maintenance. The IPAQ was used to assess achievement of PA guidelines. The Revised

Causal Dimension Scale was used to measure perceived success in meeting exercise goals. The Mindful Attention and Awareness Scale (MAAS) was used to measure trait mindfulness and the Frieberg Mindfulness Inventory (FMI) was used to assess state mindfulness. Acceptance and experiential avoidance were measured using the Acceptance and Action Questionnaire. Finally, suppression was measured using the White Bear Suppression Inventory.

Ulmer et al. (2010) found participants who perceived themselves as attaining their exercise goals scored higher on acceptance ($F(1,192) = 7.52$, $p=.007$) and state mindfulness ($F(1,192) = 6.51$, $p = .01$) measures, and reported lower suppression ($F(1,195) = 6.51$, $p = .01$) than those that did not perceived themselves as meeting exercise goals. Participants missing one full week of exercise in the previous year scored higher in acceptance ($F(1,199) = 6.05$, $p < .02$) and lower in state mindfulness ($F(1,205) = 5.42$, $p = .02$). Participants who missed two consecutive weeks of exercise in the previous year scored lower in acceptance ($F(1, 198) = 8.10$, $p = .005$) and trait mindfulness ($F(1,199) = 5.41$, $p = .02$) and higher in suppression ($F(1,201) = 6.73$, $p = .01$). Participants who missed three full weeks of exercise in a row scored lower on acceptance ($F(1,199) = 7.82$, $p = .006$) and suppression ($F(1,202) = 7.19$, $p = .008$). Finally, Ulmer et al. (2010) found that, compared to those that missed three weeks of exercise, participants who reported zero weeks of missed exercise in the last year scored higher on acceptance measures ($F(3,195) = 3.91$, $p = .01$). Overall, the results of this study support that higher levels of mindfulness and acceptance, and lower levels of suppression are related to more regular exercise, greater perceived success in meeting exercise goals, and fewer missed exercise sessions.

This study is unique from the previous studies because it measured both state and trait mindfulness. In fact, analysis of state and trait mindfulness in relation to PA found a higher amount of significant associations between state mindfulness and PA than between trait mindfulness and PA measures. The authors suggest that, "mindfulness and acceptance intervene between activity-related cognitions/emotions and overt behavior in a way that facilitates one's ability to respond to rather than react to cognitive, behavioral or emotional threats to PA" (Ulmer et al., 2010, p.807). This statement aligns with the model presented by Shapiro et al. (2006), specifically the mechanism of cognitive, emotional, and behavioral flexibility. Shapiro et al. asserts when one is more mindful, one does not overly identify with one's current experience. When an individual is aware of their automatic reaction to the experience, he or she will be able to respond with greater freedom of choice in a way that is in alignment with one's values. For example, when an individual is beginning an exercise program for the first time, a less mindful individual may feel self-conscious because they are not used to the movements and they may feel uncomfortable because they are sweaty or hot which may cause them to lose interest or quit when they don't feel like exercising. A more mindful individual, while still having the same uncomfortable experience, may be able to separate their sense of self with this unpleasant experience and choose to continue their exercise program even if they do not feel like it because they know that the experience is worth the benefits they will see.

While the results of this study seem to be promising, there are limitations. Though the population of this study was more diverse than the previous studies, the sample was still relatively homogenous. Specifically, the majority of participants in this study were

Caucasian, from a higher socioeconomic status, were physically active, and 89.8% had at least some college education. This study included a convenience sample of individuals who attend the and did not track the percentage of YMCA members that declined to participate. The study is cross-sectional limiting inferences about causality. Another way this study was limited results from the fact that the assessment tools used in this study required the use of retrospective recall data and subjective assessments of PA adherence that required the participants to recollect a year's worth of behaviors. There is also one more major limitation although not addressed by the authors. This limitation stems from the use of the FMI to assess state mindfulness. The FMI, published by Walach, Buchheld, Buttenmüller, Kleinknecht, and Schmit in 2006, is typically used to assess trait, not state mindfulness. Walach et al. suggest that mindfulness can be measured as both a state and a trait, depending on the timeframe in question, which Ulmer et al. did not report in their publication. This ambiguity may be the result of different schools of thought on what the definition of mindfulness is. Due to this ambiguity, it is difficult to determine whether state mindfulness or a combination of the state and trait mindfulness were assessed.

Mindfulness-based experimental trials. Most of the research regarding the relationship between mindfulness and PA has been cross-sectional in nature. However, there are a few published experimental studies that include mindfulness-based interventions. In 2018, Cox, Roberts, Cates, and McMahon conducted a study to explore how the induction of a mindful state during treadmill walking exercise can affect affective responses, attentional focus, perceived exertion, and enjoyment during exercise in individuals with low intrinsic motivation to exercise. Similar to Ulmer et al. (2010), Cox et al. suggest that negative affective responses (such as displeasure) during MVPA

are a barrier to engaging and/or maintaining regular PA and that these negative responses stem from feelings of discomfort experienced during exercise. They state that affective responses to exercise are the product of cognitive processes (e.g. self-efficacy, goals, attributions) and interoceptive cues (e.g. breathing, heart rate, muscle sensations) that are brought about by exercise (Cox et al., 2018). They also explain that as exercise intensity increases, attentional focus becomes more associative (meaning focused on bodily experiences) and affect becomes more negative (Cox et al., 2018). However, they also argue that induction of a mindful state may lead to a more positive affective response even at higher intensities. Cox et al. hypothesized that during the mindful condition compared to the control condition, attentional focus would be more associative, affective valence and overall enjoyment would be higher, and RPE lower during treadmill walking. Furthermore, they hypothesized that a more dissociative attentional focus and lower RPE would relate to more positive affective valence during treadmill walking and an overall measure of enjoyment in the control condition.

To test their hypotheses, the authors assessed several measures during a control condition and a mindful condition and compared these scores within subjects. The following measures were assessed: affective response via Hardy and Rejeski's Feeling Scale, attentional focus with Tammen's attentional focus scale, perceived exertion using the Borg RPE Scale, and enjoyment using the PA Enjoyment Scale during exercise and measured state mindfulness via the SMS-PA immediately following exercise. The participants for this study included sedentary individuals with low intrinsic motivation for exercise. Cox et al. included 23 undergraduate students who scored low on intrinsic motivation to exercise (mean age = 19.26 ± 1.14, 19 females, 3 males, and 1 other). The

participants were asked to come in to the lab for three different sessions. The first session was for habituation and exercise testing to obtain baseline measurements. The second session was a control condition in which the participants achieved 65% heart rate reserve for 10 minutes while listening to self-selected music. The third condition was a mindfulness condition in which the participants performed the same protocol but instead of listening to self-selected music, listened to a guided mindfulness track throughout the exercise. This mindfulness track was developed from established mindfulness scripts that focused on mindful movement and were then reviewed by two expert mindfulness practitioners.

The results of an initial ANOVA showed that there was a significant difference between the measured mindfulness scores of the control and mindful conditions ($p <$ .001). The MANOVA for in-task variables illustrated that in the mindfulness condition compared to the control condition, affective valence was more positive ($p = .02$, moderate effect), RPE was lower ($p = .06$, minimal to moderate effect), attentional focus was more associative ($p < .001$, strong effect), and enjoyment of exercise was higher ($p < .001$, moderate effect). Significant bivariate correlations between variables showed that, during the control condition, higher RPE was strongly associated with less positive affect ($p <$ .001), and during the mindful condition, higher RPE was strongly associated with less positive affect ($p < .001$) and moderately associated with lower enjoyment ($p = .05$). Higher mindfulness was moderately associated with more associative focus ($p = .01$) and higher enjoyment ($p = .04$).

The results of this study support the idea that an induction of a mindful state leads to an accepting, open, and non-judgmental associative attention that supports a more

positive affective response, a reduction of uncomfortable feelings, and an increase in enjoyment (at moderate intensity) during exercise (Cox et al., 2018). Though not statistically significant, an induction of mindfulness was also related to lower RPE, suggesting that even though the work rates remained the same between conditions, participants felt that they were not working as hard during the mindful condition. This is potentially due to the idea that when in a mindful state, individuals are more open and accepting of their physical sensations.

Despite the limitations of including a small, predominantly female and undergraduate student sample, standardizing work rate through heart rate reserve (rather than ventilatory threshold), and not randomizing participants, the findings of this study are important in a few different ways. The results of this study support the idea that by decreasing perceived exertion, increasing positive affective valence, and increasing enjoyment of PA, mindfulness can increase intrinsic motivation toward exercise. This mechanism will be addressed later in this chapter. Secondly, the findings of this study resulted from a brief, 10-minute mindfulness-based audio track, supporting the effectiveness and feasibility of this type of intervention both for future studies and in the community. While more research needs to be conducted in order to determine generalizability to the greater population, the results of this study are still promising.

While the previous study dealt with an induction of a brief mindful state in a laboratory setting, Salmoirago-Blotcher et al. (2018) wanted to determine the effectiveness of a mindfulness-based intervention in a high-school health class setting. The purpose of this study was to examine the feasibility and acceptability of integrating mindfulness training into school-based health education and to explore the effects of this

training on exercise participation. Fifty-three 9th grade health-class students were included from two different schools (to avoid contamination) and less than 40% of those students met the American Heart Association recommendation of ≥ 60 minutes of MVPA/day. Both the mindfulness intervention school and the attention control group received identical health education curriculums four times per week for two weeks. The mindfulness school received one 45-minute session of mindfulness training per week for 8 weeks, led by a certified mindfulness instructor based on the MBSR program and adapted to fit the needs of high-school aged children. Additionally, they participated in a 15-minute guided meditation (audio recording) every day in class during non-session days and were encouraged to listen to this on their own daily. The attention control school received one session per week focusing on health topics such as wellness, risk factors, mental and emotional health, self-esteem, and resiliency. Outcome assessments were performed at baseline, the end of treatment, and at a 6-month follow up. Trained personnel administered the 7-day PA recall to assess minutes of MVPA per week.

Salmoirago-Blotcher et al. found that the feasibility of this type of intervention was high: retention at the end of treatment and 6-months later were 100% and 98%, respectively. In the mindfulness cohort, students reported listening to the MF recording on average 5 times per week, 90% of the students were satisfied with the health education portion and 77% were satisfied with the mindfulness program. Analysis of PA levels showed that, at baseline, there was no difference in MVPA between groups ($p = 0.43$), that median MVPA at the end of treatment was higher in the mindfulness group by 81 minutes ($p = .005$), and this effect was maintained at 6 months of follow up ($p = .004$).

This study is limited in three main ways. The first of which is the small number of participating schools and the small sample size within those two schools. The second limitation is that PA levels were self-reported and subject to recall bias. The last limitation of this study was the lack of mindfulness assessment thereby not allowing the an evaluation of the improvements in mindfulness skills from baseline to the end of treatment. The strengths of this study were inclusion of ethnically diverse populations, use of a control condition, the integration of mindfulness training in a pre-existing health education class at the school, and the inclusion of fidelity checks to ensure that all planned topics were discussed. While this study did not delve into any potential mechanisms, it was able to add to field by establishing the potential for a school-based mindfulness program that is feasible to deliver and effective in changing self-reported outcomes.

Meyer et al. (2018) also investigated the effects of a mindfulness-based intervention on PA levels. The primary purpose of this study was to compare the effects of an 8-week MBSR program, aerobic exercise training (AET) program, and a no-treatment control group on the objectively measured PA and sedentary behavior during the autumn season. To date this is the only study that utilized objective measures of PA. The AET group was included in this study because Meyer et al. suggest that AET and MBSR result in similar psychological benefits, namely mindful focus during training and stress reduction, and would thus be a valid comparator. This study included two specific aims: the first was to determine if the MBSR and AET programs differentially influenced objective PA and weekly exercise compared to a no-treatment group, and the second was to determine if MBSR and AET programs alter sedentary behavior.

To answer these questions, Meyer et al. ran a secondary analysis on pre-existing RCT data. Overall, the analysis included 49 participants (mean age = 51.9 ± 11.1, 90% Caucasian, and 98% having at least some college education). PA was measured through use of the ActiGraph GT3X+ accelerometer, which had to be worn at least 10 hours per day on at least three weekdays and one weekend day before and after the intervention. At baseline, participants averaged 11.5 hours/day of sedentary time, 2 hours/day of light-intensity PA, slightly under 1 hour/day of moderate-intensity PA, and 10 minutes/day of vigorous-intensity PA. The MBSR group was instructed by facilitators certified through the Center of Mindfulness at the University of Massachusetts Medical School and was taught in the standard 8-week format, with one 2.5 hours session per week. The AET group format was also 8-weeks in duration and included one 2.5-hour session a week in which the first 1.5 hour was classroom-based instruction and the last hour included group activity at a fitness center. At the end of the eight weeks, the AET group participated in PA retreat day. The instructors of the AET group were certified clinical exercise physiologists with Master's level education or higher.

The results of this study showed that, from August (pre-enrollment) to November (post-intervention), daily MVPA in all groups decreased with no significant difference between the groups. The MBSR group decreased 5.7 ± 7.5 minutes per day, the AET group decreased 7.4 ± 14.3 minutes per day, and the control group decreased 17.9 ± 25.7 minutes per day. MVPA bouts lasting at least 10 minutes decreased 15.5 ± 37.0 minutes per week, 5.7 ± 64.1 minutes per week, and 77.3 ± 106.6 minutes per week in the MBSR, AET, and control groups respectively. There were no significant differences between the MBSR and AET groups for this metric, however there was a significant difference

between the AET and control group ($p = 0.029$; $d = 0.97$) There were no significant findings regarding sedentary time between the groups or of group by time.

Meyer et al. (2018) state the significant difference in the preservation of 10+ minute bouts of exercise demonstrated in the AET group over the control group shows the benefit of type of training. Unexpectedly, there was no significant difference between the MBSR group and the AET group, which indicated that both groups may have similar effects in the preservation of PA levels. This is especially interesting considering a standard MBSR intervention does not target PA behavior. One possible explanation for this finding can be drawn from the study by Roberts and Danoff-Burg (2010), who suggested that an increase in trait mindfulness resulting from the MBSR program could lead to decreased stress levels, which may translate to increased positive health behaviors. Meyer at al. (2018) state that this may be especially important when traditional exercise programs or interventions may not be feasible, such as after surgery or during chemotherapy.

The study by Meyer et al. (2018) was limited for several reasons. First, it was a secondary data analysis of a study designed to evaluate the influence of AET and MBSR on acute respiratory infections. Second, the study had limited statistical power because of relatively small group sizes. The next limitation was that while accelerometers can provide accurate measures of PA, they are unable to collect contextual information regarding PA and sedentary behavior. The authors also state the seasonal nature of the trial was a limitation as PA levels decrease naturally from the end of summer to the end of fall. One final limitation present in this study was the lack of any assessment of either trait or state mindfulness. While it can be inferred that mindfulness skills increase in the

MBSR group, there is no way to know this without assessing this metric. There are also plenty of strengths present in this study: both the MBSR and AET groups were taught by highly qualified facilitators, the AET cohort included a group setting, a session duration equivalent to the MBSR cohort, and a retreat at the end of the intervention. These three aspects of the AET group are important as they were intended to control for aspects that are present in the standard MBSR intervention. Finally, this is one of the few published studies that analyzed objective PA data in conjunction with a mindfulness-based intervention.

Acceptance and commitment therapy RCTs. Up to this point, the studies regarding mindfulness and PA were either cross-sectional, investigated an acute bout of mindfulness induction, or were based on the MBSR intervention made popular by Dr. Kabat-Zinn. There is, however, another type of mindfulness-based intervention with promise for the promotion of PA. Acceptance and Commitment Therapy (ACT), in the context of health behaviors, is a type of mindfulness-based cognitive therapy that aims to increase adherence to a specific type of health behavior (i.e. PA). To do this, the goal of ACT is to increase psychological flexibility, defined as "the ability to contact the present moment more fully as a conscious human being, and to change or persist in behavior when doing so serves valued ends" (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). To do this, it targets six different core processes: acceptance, cognitive defusion, being present, self as context, values, and committed action. While the process of values is nearly identical to the mechanism of values clarification in mindfulness, the first four of these processes related to mindfulness will be explored further in the subsequent paragraphs.

Though ACT shares many similarities and constructs with the model of mindfulness introduced by Shapiro et al. (2006), there are some distinctions that make it a unique psychological model. The first of the core processes mentioned by Hayes et al. (2006) is the process of acceptance. They state that this is the opposite of avoiding experiences and involves the active embrace of negative experiences without attempting to change them. According to Shapiro et al (2006), acceptance is included as part of the axiom of Attitude in that bringing patience, compassion, and non-striving to the practice of paying attention allows an individual to be non-judgmental about their experiences.

The next two processes are related to the mindfulness meta-mechanism of reperceiving. These two processes are Self as context and cognitive defusion. Self as context is the shift from the idea that the self is that which is observed as an object in consciousness to the idea that the self is that which is doing the observing (Shapiro et al., 2006). This process aligns almost exactly with the shift in perspective known as reperceiving. Cognitive defusion is a process in which an individual attempts to change the way that one interacts with, or relates to thoughts in order to decrease attachment to, or meaning of cognitive experiences. This concept of cognitive defusion is also shared with the mindfulness concept of reperceiving. However, in mindfulness, rather than decreasing the attachment to a cognitive event, reperceiving offers clarity while enabling individuals to fully experience events without identifying with or clinging to them.

The final process of ACT that Shapiro et al.'s model is being present. In ACT, this is ongoing non-judgmental contact with internal experiences (thoughts, feelings, and emotions) so that an individual can exert more control over their behavior (Hayes et al. 2006). This is similar to the axiom of Attention in mindfulness as described by Shapiro et

al. (2006) as the inhibition of secondary elaborative processing of thoughts, feelings, and sensations. However, this core process in ACT differs from the axiom of Attention because it does not include the capacity to attend for long periods of time on a single object or the ability to shift the focus of attention between objects or mental sets willfully.

Conceptually, there are many similarities between the mindfulness model presented by Shapiro et al. (2006) and Acceptance and Commitment Therapy. The main point of distinction lies in the fact that mindfulness, in of itself, is not an intervention. It is a practice, a trait, and a state that enhances other interventions. ACT and MBSR are only two of many interventions based on the idea that mindfulness can be used to enhance other interventions. The inclusion of mindfulness in a program often results not only in improvements in the target outcomes, but participants can see positive changes in other areas of their lives. For example, an individual participating in a mindfulness-based smoking cessation program has the overarching goal of quitting smoking, but may learn mindfulness skills that help them deal with stress in other areas of their lives as opposed to just quitting smoking. With that being said the following RCTs regarding ACT and PA help demonstrate the efficacy of incorporating mindfulness into PA interventions.

Tapper et al. (2009) conducted the first RCT that utilized an ACT intervention. In this study, the researchers sought to explore the efficacy of a mindfulness-based weight loss intervention for women. To do so, the authors employed an RCT design in which 62 female participants (mean BMI of 31.57, mean age of 41 ± 13 years) were randomly allocated to an intervention group, based on ACT adapted for weight loss, or a no-treatment control group. The intervention, while targeting weight loss as the primary outcome, also included self-reported PA levels as an outcome using the Brief Physical

Assessment Tool (BPAT). The BPAT measures PA in three ways: 1) the number of 30-minute bouts of moderate intensity PA a week, 2) the number of 30-minute bouts of walking in a week, and 3) the number of 20minute bouts of vigorous intensity PA in a week (this is scored as two sessions). Key components that were included in the intervention were values to enhance motivation, cognitive defusion to help break the links between exercise- and food-related thoughts and behaviors, and acceptance to help tolerate negative experiences. The intervention was delivered via three workshops a week conducted over a three-week period with an additional 3 workshops in one week three months later. Each session lasted 2 hours and was set of in a classroom format. For both the intervention and control group, the investigators followed up at 4 and 6 months.

The results of this study showed that while the intervention group presented with only a small non-significant decrease in BMI (-0.31 kg/m^2) and weight (-1.35 kg), there was a significant increase in self-reported PA in the intervention group equivalent to an increase of 2.8 sessions per week ($p < .05$). When compared to the control group, the intervention group also showed significantly greater increases in PA ($t(44) = 2.46$, $p = .018$).

Although the decrease in BMI and weight seen in the intervention group was non-significant, the authors suggest that this may be due to the relatively brief intervention time when compared to CBT weight loss programs. The ACT intervention in this study amounted to only 8 hours total compared to the 20-40 hours included in CBT programs. While this distinction may be important if the outcome was weight loss, the fact that 8 hours of intervention can cause significant increases in self-reported PA, even at 6 months follow-up, is an important finding.

This exploratory study was limited in that it included a no-treatment control as opposed to comparting the ACT intervention to the standard weight loss treatment. Additional limitations include the short 6-month follow up evaluation, the fact that the control and intervention groups were not matched for PA at baseline, the female only sample, and the self-reported measure of PA.

While the previous study only investigated PA in the context of weight loss, Butryn et al. (2011) performed a pilot study with the aim of collecting information regarding efficacy of an ACT intervention for the short-term promotion of PA. The authors hypothesized that, at the end of an 8-week intervention, participants who were assigned to an ACT intervention group would have greater increases in PA levels compared to a control group that received PA education material.

Butryn et al. randomly assigned fifty-four non-freshman, female college students (mean age = 23.1 ± 3.8, 57.2% Caucasian) into either a PA education control group or the ACT group. All participants attended two, 2-hour group sessions, which were held two weeks apart. Assessments were conducted at three time points: week one (baseline), week 5 (post-intervention), and week 8 (follow-up), with intervention sessions occurring at week 2 and week 4. Butryn et al. were interested in four measurements: PA participation (assessed by recording a participant's visits to the school recreation center and tracked by scanning ID cards), mindful awareness (measured by the Philadelphia Mindfulness Scale), defusion from negative internal experiences (by use of the Drexel Defusion Scale), and PA experiential acceptance (through use of an adapted Chronic Pain Acceptance Questionnaire).

The results of this pilot study indicated that, when compared to the education group, participants who participated in the 4-hour ACT intervention had significantly more visits to the athletic center between baseline and post-intervention ($F(1, 42) = 7.33$, $p < .01$, $\eta^2 = .15$).However. this difference was not significant at an 8-week follow-up. While a repeated measure MANOVA indicated an increase in mindful awareness and experiential acceptance in both groups, there was no significant difference between the groups. The MANOVA also indicated a significant difference in defusion scores between groups ($p < .05$), such that defusion scores increased in the interventions group and decreased in the control group. The authors indicate that that the increase in PA levels potentially results from the increased defusion scores seen in the intervention group, saying that being able to distance themselves from thoughts such as "I'm too tired to exercise today" allows the individual to realize that this thought is not a "truth."

This study is limited in its small and homogenous sample size, the short exposure to the intervention, the use of check-ins alone as a measure of PA as opposed to objective or self-report measures, inadequate statistical power for mediation analysis, and the short follow-up period. Considering the fact that this was a pilot study, the fact that only two intervention sessions doubled the amount of athletic facility check-ins speaks to the potential of ACT-based PA interventions.

The final RCT that utilized an ACT intervention to increase PA was performed in by Kangasniemi et al. in 2015. The aim of this study was to compare the effectiveness of a feedback (FB) control group and a FB plus ACT group intervention on PA and exercise related cognitions in sedentary adults. Kangasniemi et al. hypothesized that the ACT +

FB group would be more effective than the FB group for the increase of PA and enhancement of exercise-related cognitions.

They tested this by randomly assigning 138 sedentary working adults (mean age = 43.5 years, 83.3% female) into either the FB group or the ACT + FB group. The FB control group received feedback on objectively measured PA levels at baseline, 3-month, and 6-month follow up, asked to keep a diary of PA, and had the option to attend a body composition analysis. Those assigned to the ACT+FB group received the same feedback but also participated in an ACT-based group program. This program consisted of six, 90-minute sessions over nine weeks. Measurements for both groups were taken at baseline, three-months, and six-months. Measurements regarding PA included objective PA data (measured via ActiGraph GT1M or GT3X accelerometers) and an assessment of self-reported PA levels (using items developed for this study by the investigators). Kangasaniemi et al. also included psychometric measures as part of their investigation. They collected data on beliefs and intentions in regard to exercise (i.e. exercise adoption self-efficacy, exercise barrier self-efficacy, and exercise coping planning), acceptance of PA (measured by the Physical Activity Acceptance Questionnaire), and depressive symptoms (as measured by the Beck Depression Inventory – Revised).

Kangasaniemi et al. (2015) found significant increases over time in objectively measured PA for both the FB ($\chi2 = 8.585$, $p = 0.014$) and ACT + FB ($\chi2 = 13.114$, $p = 0.001$) groups. Significant increases in objective PA were also seen at three months in both the FB ($\chi2 = 8.755$, $p = 0.013$) and ACT + FB ($\chi2 = 9.606$, $p = 0.008$) groups. There were no significant differences between groups at any point of measurement. The ACT + FB group displayed significant improvements in exercise adoption self-efficacy ($\chi2 =$

12.310, p = 0.002), self-efficacy to face exercise barriers ($\chi 2 = 17.388$, $p < 0.001$), the ability to plan and cope with exercise ($\chi 2 = 96.073$, $p < 0.001$), and acceptance of physical discomfort related to exercise ($\chi 2 = 38.499$, $p < .001$). The FB displayed only significant improvements in exercise coping planning ($\chi 2 = 11.913$, $p = 0.003$). Additionally, after controlling for depressive participants, the ACT + FB group showed improvements in PA levels that were maintained longer than in the FB group. Limitations present in this study include the use a homogenous sample, limiting the ability generalize the results beyond sedentary women inclined to participate in this type of program. It is also limited in that accelerometers are not able to capture all types of PA effectively (e.g. swimming and biking) and the act of wearing an accelerometer itself may have an effect on PA behavior. Lastly, Kangasaniemi et al.'s study is limited in that the improvements in exercise cognition seen in the FB + ACT group may be the result of the extra attention received compared to the FB group.

Mindfulness, Physical Activity, and the Self-Determination Theory

Earlier in this chapter, self-regulation was briefly discussed as one of potential mechanisms through which mindfulness could impact PA behavior. This section will further explore how this mechanism relates to PA from the perspective of the Deci and Ryan's (1985) Self-Determination Theory (SDT), but first the connection between mindfulness and the SDT must be explained. Concisely, the SDT is a theory of motivation and development that proposes humans act to fulfill three basic psychological needs: competence (mastery and efficacy), relatedness (a sense of belonging or being cared for), and autonomy (volition and self-endorsement of one's behaviors). To satisfy those needs, individuals need to act in autonomous or self-determined ways (Schultz &

Ryan, 2015). According to Deci and Ryan (1985), human motivation exists on a spectrum that includes three types of motivation: intrinsic motivation (behavior driven by satisfaction), extrinsic motivation (behavior driven by the expectation of a certain outcome), and amotivation (the lack of intention to behave in a certain way). Extrinsic motivation is then broken down further, ranging from highly controlled (external regulation) to highly autonomous (integrated regulation). Deci and Ryan found the psychological need for autonomy is most fulfilled when an individual is intrinsically motivated, however, much of our behavior is extrinsically motivated. Schultz and Ryan relate this to health behaviors and well-being in that "more effective behavioral regulation and enhanced well-being are associated with higher relative autonomy" (Schultz & Ryan, 2015, pp. 83). They further connect this to mindfulness by saying the increased ability to openly attend to one's experiences brought about through the practice of mindfulness enables self-insight and self-reflection so that there is congruence between one's values and goals and one's behaviors, thus satisfying the need for autonomy. Levesque and Brown summarized the link between the SDT and mindfulness succinctly in their 2007 study, stating that in the SDT, awareness enables self-regulated functioning and that higher levels of trait mindfulness was linked to higher levels of self-regulated behavior.

Ruffault, Bernier, Juge, and Fournier (2016) were the first to connect the relationship between mindfulness and PA to the Self-Determination Theory. Ruffault et al. (2016) state that one could change their PA behaviors if the PA behaviors result in pleasure and satisfaction and if the individual values the new behavior. This idea in the context of PA is supported by Fortier, Sweet, O'Sullivan, and Williams (2007) who

found that “patients [in the autonomy supportive PA counseling group] reported higher levels on the autonomy support index, had higher levels of autonomous motivation mid-intervention, which translated into higher levels of PA at the end of the intervention” (p.752). Therefore, the aim of the study by Ruffault et al. (2016) was to elucidate the relationships between intrinsic motivation for exercise, mindfulness, and PA levels.

The authors examined these relationships by developing five different models which they believed could potentially explain the aforementioned relationships. For their study, Ruffault et al. recruited 244 French students (58.21% female, mean age = 21 ± 2.73) and asked them to fill out a series of questionnaires measuring PA levels, motivational regulation towards exercise, and dispositional mindfulness. The survey instruments that they used included: the French version of the IPAQ, the Behavioral Regulation towards Exercise Questionnaire, and the MAAS, respectively. After running a correlational analysis, Ruffault et al. (2016) found self-reported mindfulness was positively correlated with the two autonomous motivational regulations, intrinsic (τ =.17, $p<.05$) and identified (τ =.11, $p<.05$) regulation, and negatively correlated with the controlled motivational regulations, external regulation (τ = -.11, $p<.05$) and amotivation (τ = -.25, $p<.05$). Furthermore, the results also showed that PA levels showed positive correlations with both intrinsic (τ = .21, $p<.05$) and identified (τ = .20, $p<.05$) regulations, but were not significantly correlated with mindfulness. Hierarchal regression analyses supported that their moderation model explained the greatest variance in PA level ($R2=11.97$ %; $F(3, 240)=10.88$; $p<.001$) such that “when self-reported mindfulness is low, intrinsic motivation is not related to PA level. But, as self-reported mindfulness

increases, the link between intrinsic motivation and PA levels becomes positively correlated and much stronger" (Ruffault et al., 2016, p.449).

The above results suggest that an increase in trait mindfulness leads to healthier and more intrinsically motivated behaviors choices (Ruffault et al., 2016). There are multiple explanations of why this may be so. First, is the idea that by becoming more aware of habitual or automatic behaviors or responses, one can inhibit impulsive actions and allow individuals to make decisions that are beneficial to their health. Second, when one is more mindful, that individual is more aware of their present experience and more accepting and less judgmental. This open and accepting awareness us to the mechanism of self-regulation, which in turn is linked to freedom to choose behavioral responses that are in accordance with one's values (Brown & Rayn, 2003; Ruffault et al., 2016). Overall, the findings of this study support the idea that mindfulness is a key factor that links intrinsic motivation and PA behaviors.

Due, to the subjective assessment of PA, the conclusions of this study are limited to the participants' self-perceptions. It is also limited by the cross-sectional design of the study. By only collecting data at one point in time, conclusions as to causality cannot be drawn and furthermore, other variables (e.g. psychopathology, time for leisure, or environmental factors) that may explain the relationship between PA behaviors and motivational regulation cannot be ruled out. Additionally, the use of a single-factor scale to measure mindfulness may have limited this study as a multi-factor scale may have provided more details about the investigated relationships. Finally, the use of homogenous participants may have limited the ability to apply the findings of this study to a wider population. Despite these limitations, Ruffault et al. were the first to link all

three variables of PA, mindfulness, and intrinsic motivation in a meaningful way. They proposed multiple ways in which this relationship works, paving the way for some unique PA interventions based upon this moderation model.

In the previous study by Ruffault et al. (2016), the authors state behavior change can occur if one finds pleasure and satisfaction in the new behavior. According to the Deci and Ryan's (1985) SDT, one is acting autonomously when they are intrinsically motivated and intrinsic motivation is driven by satisfaction. Tsafou, De Ridder, van Ee, and Lacroix (2016) claim that satisfaction is a key factor in the maintenance of a behavior and that mindfulness may be an important factor contributing to a satisfying experience when engaging in a new activity. Tsafou et al. (2016) argue that "mindfulness may intensify the recognition and experience of positive instances as relevant for the experience of satisfaction with PA" (p. 1818), that satisfaction is evaluated during or after PA, and that mindful attention and awareness precedes this evaluation. They also state that habitual performance of PA may, in fact, decrease satisfaction experienced due to the less mindful and automatic nature of habitual behaviors. Therefore, the authors hypothesized that the relationship between mindfulness and PA is mediated by satisfaction.

In order to test this hypothesis, Tsafou et al. (2016) conducted a cross-sectional examination in which they sampled 398 Dutch speaking participants (50.3% female, mean age = 41.28 ± 13.27, 17.3% low-education, 52% middle-education, and 30.6% high-education). The authors used the MAAS to measure trait mindfulness, the IPAQ-Short Form (IPAQ-SF) to measure PA, the Self-Report Habit Index to measure exercise habit strength, and two self-developed scales: the Mindfulness in Physical Activity

(MFPA) scale to measure state mindfulness during exercise, and a Satisfaction scale to measure satisfaction with the outcomes of PA.

A mediation analysis was performed and the findings supported the authors' hypothesis that satisfaction is mediator in the relationship between mindfulness and PA. Habit played a significant role in this relationship as well, such that when one has a weak habit for PA, mindfulness plays a stronger role on satisfaction whereas when one has stronger PA habits, the effects of mindfulness on satisfaction are not present. (Tsafou et al., 2016). The results of this study are important as they support the findings of Ulmer et al. (2010) which suggest that mindfulness is related to the maintenance of exercise behaviors. Surprisingly, Tsafou et al. (2016) found no significant correlation between trait mindfulness as measured by the MAAS and PA, a finding that is not mentioned throughout the authors' discussion.

One of the major limitations present in this study is the large amount of missing data and mistakes made by the participants during completion of the IPAQ. Due to this, Tsafou et al. excluded a total of 103 participants from their analyses. Having to remove such a high number of participants from their study may have resulted in the null association found between trait mindfulness and PA levels. Another limitation of this study is its cross-sectional design, making inferences of causality impossible and necessitating the use of caution when interpreting the mediation effects of satisfaction between mindfulness and PA. The final limitation of this study resulted in Tsafou et al. being unable to draw any conclusions about the differences between PA maintainers and PA initiators due to vastly unequal group sizes.

In 2017, Tsafou, Lacroix, van Ee, Vinkers, and De Ridder sought a deeper understanding of the results found during the previous study by developing mediation models in an attempt to explain the interplay between state mindfulness, satisfaction, trait mindfulness, and engagement in PA. They hypothesized that higher state mindfulness is related to increased PA via satisfaction. In addition to confirming this hypothesis, Tsafou et al. (2017) were also interesting in finding out how trait mindfulness fits into this relationship. To do this, the authors obtained self-reported data on 305 Dutch-speaking adults (mean age = 40.7 ± 13. 51.1% female). They again used the IPAQ-SF to measure PA, the 12-item Self-Report Habit Index to measure PA habit strength, the MFPA to measure state MF during exercise, a modified version of their previous scale to measure satisfaction with PA, and to measure trait MF they used both the MAAS and the FFMQ (though they only included results from the MAAS).

The results of this study support their previous conclusion that satisfaction explains the positive association between state mindfulness and PA. In order to explore the role of trait mindfulness, they tested a serial mediation model showed significant indirect effects of trait mindfulness on PA first through state mindfulness and then through satisfaction (.017, SE = .010, 95% CI = [.002; .042]). Tsafou et al.'s (2017) study shares limitations with the previous study by Tsafou et al. (2016) in that it is a cross-sectional design and thus causality cannot be inferred. Tsafou et al. (2017) also report that their use of the short form of the IPAQ to measure PA may lead to over reporting of moderate and vigorous PA. Finally, the study was also limited by the fact that trait and state mindfulness were not measured in the same way. The survey used to measure state mindfulness only addressed the mindfulness aspect of awareness while trait mindfulness

measures also include acceptance (in the case of the MAAS) or the other facets of mindfulness (e.g. Observe, Describe, Non-react, etc.) that are assessed in the FFMQ. By not accounting for other dimensions of mindfulness during the assessment of state mindfulness, the authors are unable to rule out any other confounding variables that may explain their results.

While Tsafou et al. (2017) do not delve deeply into the meta-mechanisms of mindfulness in their discussion, they do explain their results in the context of satisfaction. They first explain that state mindfulness enhances present moment experience in ways that increase satisfaction with PA behaviors. Baldwin, Baldwin, Loehr, Kangas, and Frierson (2013) write that satisfaction is a key determinant of health behavior maintenance and that PA is no exception. They state there are two main factors associated with increased satisfaction with PA: perceived progress towards goals and positive experiences. From the SDT (Deci & Ryan, 1985) and Ruffault et al. (2015), it is known that individuals are more likely to engage in (and maintain) health behaviors when they have higher autonomy and are motivated more by internal factors rather than external factors. As mentioned above, two key factors that lead individuals to become more internally motivated are enjoyment of an activity and by engaging in behaviors that are aligned with their goals or values. By acting in accordance with one's values and enhancing enjoyment of a particular health behavior, satisfaction with said behavior increases. According to Shapiro et al. (2006), the first of these two factors, progress towards goals or acting according to personal values, is related to mindfulness because when one is acting mindfully, that individual is able to make a conscious decision to

engage in behaviors that are congruent with their values. The second factor, enjoyment of an activity, is also related to mindfulness and will be discussed later in this section.

The findings by Tsafou et al. (2017) provide even more insight into the relationship between mindfulness, PA, and satisfaction. Their model shows that trait mindfulness indirectly effects PA. That is, individuals with higher trait mindfulness have higher state mindfulness during exercise. As a result, this increases an individual's satisfaction with exercise and thus helps them maintain that behavior. This model also aligns with mindfulness mechanisms in that, rather than focusing on the difficulty and discomfort of exercise, a more mindful individual is able to take a step back and accept these unpleasant experiences so that they know they are acting in alignment with their goals and can enjoy the pleasant experiences of exercise.

In 2018, Cox, Roberts, Cates, and McMahon conducted the first controlled trial that investigated the link between PA and mindfulness. Cox et al. stated that negative affective responses (e.g. displeasure) during exercise make it less likely that an individual will less likely that this individual will maintain PA participation over time, but that an induction of a mindful state during exercise would attenuate the negative affective responses. hey hypothesized that attentional focus would be more associative (when attention is focused on the experiences of the body), that affective valence (attitude) and enjoyment of exercise would be higher, and that the rating of perceived exertion would be lower during the mindfulness condition than in the control condition. Their second hypothesis was that during the control condition, a more dissociative (actively drawing attention from the body's experience) attentional focus and that lower RPE would be associated, firstly, with a more positive affective valence during exercise and, secondly,

would relate to an overall measure of enjoyment, and that these relationships would be weaker during the mindfulness condition.

In order to test their hypotheses, Cox et al. took 23 sedentary undergraduate students with low intrinsic motivation to exercise and had them complete three treadmill walking sessions. The first session was used for habituation and exercise testing to obtain baseline measurements. The second session was a control condition in which the participants achieved 65% heart rate reserve for 10 minutes while listening to self-selected music. All participants completed the control condition prior to the mindful condition. For the final, mindful induction session, the participants performed the same protocol as the control condition. However, rather than listening to self-selected music throughout the course of the exercise, participants instead listened to a guided mindfulness track. This track was developed based off of established mindfulness scripts that focused on mindful movement and were then reviewed by two expert mindfulness practitioners throughout the exercise. Affective valence was assessed before, during, and after exercise using Hardy and Rejeski's (1989) 11-point, single-item Feeling Scale. Attentional focus was assessed, using Tammen's (1996) attentional focus scale, immediately following exercise to determine how internal or external the participant's focus was during the exercise. Perceived exertion (Borg RPE Scale) was assessed at the four- and eight-minute time points during exercise. The researchers assessed state mindfulness (State Mindfulness Scale for Physical Activity) and enjoyment of PA (The Physical Activity Enjoyment Scale) no later than five minutes after the exercise had concluded.

The results of the main analyses established that there was a significant difference between the measured mindfulness scores of the control and mindful conditions ($F = 14.53$, $df = 1, 22$, $p < .001$, $\eta_p^2 = .40$). In the mindfulness condition compared to the control condition, affective valence was more positive ($F = 6.06$, $df = 1, 22$, $p < .05$, $\eta_p^2 = .22$), RPE was lower (though this was only approaching significance), attentional focus was more associative ($F = 43.84$, $df = 1, 22$, $p < .001$, $\eta_p^2 = .67$), and enjoyment of exercise was higher ($F = 12.29$, $df = 1, 22$, $p < .001$, $\eta_p^2 = .36$). They also found that for both the control and mindfulness conditions, higher RPE was associated with less positive affective valence, $r = -.79$ ($p < .05$) and $r = -.74$ ($p < .05$), respectively. These results suggest that when participants were more open, accepting, and nonjudgmental during the mindful condition, they had not only a better attitude toward exercise, but also had a reduction in the discomfort brought about by the exercise. In turn, this increased enjoyment during the exercise.

Despite the limitations of including a predominantly female population, standardizing work rate through heart rate reserve (rather than ventilatory threshold), and not randomizing participants, the findings of this study directly support the mediation model proposed by Ruffault et al. in 2016 and also support the findings of Tsafou et al. (2016; 2017). They state that mindfulness affects PA via intrinsic motivation which can be increased by enhancing enjoyment or decreasing perceived negative effects of exercise. It is also important to note the ease in which they induced a mindful state in their participants. The results above showed that a 10-minute mindfulness-based audio track was sufficient to increase participants' enjoyment and intrinsic motivation to exercise (at least for the time it took to finish the exercise protocol). This has a practical

application for exercise and health professionals/researchers as it may lead to an effective and feasible way to help promote PA.

To summarize, the relationship of between mindfulness and PA is a promising avenue of investigation. Mindfulness is correlated with self-reported PA in many studies (Chatzisaeantis and Hagger, 2007; Gilbert and Waltz, 2010; and Ulmer, Stetson, and Salmon, 2010; Ruffault et al., 2016; Tsafou et al., 2016; Tsafou et al., 2017). Gilbert and Waltz (2010) examined possible mechanisms for the relationships between mindfulness, PA and self-efficacy. Ulmer, Stetson, and Salmon (2010) also explored potential mechanisms by examining the relationship between PA, acceptance, and mindfulness. However, the most support in the literature was for the self-determination theory and intrinsic motivation (Ruffault et al., 2016; Tsafou et al., 2016; Tsafou et al., 2017, Cox et al., 2018). These studies demonstrated that components of intrinsic motivation (e.g. satisfaction or enjoyment) might explain the relationship between trait mindfulness and PA behavior. The findings suggest mindfulness may be a moderator between intrinsic motivation and PA. Their findings show that the strength of the relationship between intrinsic motivation and PA levels becomes stronger and positively correlated as mindfulness scores increase. In other words, mindful individuals are more likely to have increased levels of PA when they have higher levels of intrinsic motivation, while individuals with low scores of mindfulness are less likely to be physically active even if they have high levels of intrinsic motivation. Furthermore, Cox et al. (2018) compared a control treadmill walking session to an experimental, mindful treadmill walking session and found that compared to the control session, participants experienced more enjoyment, slightly lower RPE, and a better attitude during the mindful walking session. The

implications of this trial demonstrate that mindfulness may be an important tool to use when individuals have a strong aversion to PA.

Despite the support this idea has received in the literature, there are no published studies that have assessed trait mindfulness, behavioral regulation toward exercise, exercise intention, perceived stress, and subjective PA together in a single study. For this reason, the purpose of the present study was to associations between these factors and to determine if trait mindfulness is independently associated with meeting PA guidelines.

CHAPTER 3

METHODS

Study Design

The purpose of this study was to examine the relationships between trait mindfulness, PA, behavioral regulation toward exercise, exercise intention, and stress. This study utilized a cross-sectional design. We collected primary data from undergraduate students at a large southwestern university. Participants completed the Mindful Attention and Awareness Scale (MAAS), the Philadelphia Mindfulness Scale (PHLMS), the Behavioral Regulation toward Exercise Questionnaire - Revised (BREQ-II), the Perceived Stress Scale (PSS), the International Physical Activity Questionnaire (IPAQ), and items assessing intention to exercise.

Participants and Recruitment

Participants were undergraduate students at a large university in the Southwestern United States. To be included in the study, participants must have been either a part-time or a full-time undergraduate student at one of the four university campuses or have been taking classes online. Participants must have been between the ages of 18 and 24 years. Male and female students were both eligible for participation. Participants were excluded from this study if they had known contraindications to exercise as assessed by answering yes to any of the questions on the PARQ+. Students who were not registered in classes at the university at the time they completed the survey were also excluded from the study. Participants were recruited from all four campus and online locations within the university. Participants were recruited through an online course titled: Fitness for Life (a class meant for non-exercise science students), through advertisements on the MyASU

website, through social media platforms, and recruitment flyers placed around the different campuses. All sources included a link that, once selected, directed them to an information letter and eligibility screener describing the purpose and requirements of the study. If individuals qualified for the study based on responses to the eligibility screener, they were provided with a link to the study's survey. Approval from the Institutional Review Board (IRB) at Arizona State University was obtained prior to the collection of data. All participants provided informed consent prior to participating in the study.

Sample Size. Using a two-sided test, 5% significance level test (α=0.05) with a power of 0.80 (Beta= 0.2) the required sample size to detect a correlation of 0.40 is 47 (https://www2.ccrb.cuhk.edu.hk/stat/other/correlation.htm). Using the same criteria, the required sample size necessary to detect a correlation of 0.3 and 0.35 is 85 and 62 respectively.

Data and Instrumentation

Study Variables. The independent variables for this study were trait, or dispositional, mindfulness, behavioral regulation toward exercise, intention to exercise, and perceived stress while the dependent variable is leisure time moderate-to-vigorous physical activity levels. Demographic information for participants was also be collected.

Demographics. Data collected included: age, gender, ethnicity, race, academic year, major, enrollment status, campus attended, on- or off-campus housing, employment status, previous participation in sports or PA, and meditation experience.

Trait Mindfulness. Trait mindfulness has been described as "the degree of day-to-day mindful attention that varies in quality and frequency between individuals" (Brown

& Ryan, 2003). This variable was measured through two questionnaires: the Mindful Attention and Awareness Scale and the Philadelphia Mindfulness Scale.

Mindful Attention and Awareness Scale (MAAS; Brown & Ryan, 2003). The MAAS is a unidimensional, self-report measurement instrument intended to assess both attention and awareness in order to combine these two aspects into a global trait mindfulness score. For the purposes of this scale, Brown and Ryan (2003) have defined mindfulness as "the state of being attentive to and aware of what is taking place in the present" (p. 822), awareness as "the background "radar" of consciousness, continually monitoring the inner and outer environment" (p. 822), and attention as, "a process of focusing conscious awareness, providing heightened sensitivity to a limited range of experience" (p. 822). According to Brown and Ryan (2003), the MAAS displays very good internal consistency with university student populations (n = 327), with an alpha coefficient of .82. The scale also demonstrated a 4-week test-retest reliability correlation of .81 ($p < .0001$). The MAAS consists of 15 items and contains questions like, "I could be experiencing some emotion and not be conscious of it until some time later." All items are rated on a 6-point Likert scale with response options ranging from "1 = Almost Always" to "6 = Almost Never." To score, compute the mean of the 15 items. A high score reflects higher levels of dispositional mindfulness.

Philadelphia Mindfulness Scale (PHLMS; Cardaciotto et al., 2008). The PHLMS is a bi-dimensional, self-report measurement instrument intended to assess two key components of trait mindfulness: present-moment awareness and acceptance. For the purposes of this questionnaire, awareness is conceptualized as "a continuous monitoring of experience with a focus on current experience rather than preoccupation with past or

future events" (Cardaciotto et al., 2008) and acceptance as the quality to which awareness is conducted: "nonjudgmentally, with an attitude of acceptance, openness, and even compassion towards one's experience" (Cardaciotto et al., 2008).

According to the authors, Cardaciotto et al. (2008), the PHLMS demonstrates very good internal consistency in normative (those not receiving psychiatric or psychological treatment) undergraduate psychology student populations (n = 204) for both the Awareness and Acceptance subscales with alpha coefficients of .75 and .82, respectively. For the same population sample, Cardaciotto et al. (2008) also report acceptable inter-item correlations ranging from .13 to .36 for the Awareness subscale and .17 to .53 for the Acceptance subscale. Finally, the corrected item-to-total correlations for the Awareness and Acceptance subscales were .34 to .51 and .40 to .64, respectively.

The PHLMS consists of 20 items, and each subscale consists of 10 items. Items 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 assess Awareness and include statements such as "I am aware of what thoughts are passing through my mind." Items 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 assess Acceptance and include statements such as "I try to distract myself when I feel unpleasant emotions." All items are rated on a 5-point Likert scale with response options ranging from "1 = never" to "5 = very often". To score, all Awareness items are totaled with higher scores reflecting higher levels of awareness, and all Acceptance items are reverse scored (meaning 1 is scored as 5, etc.) and totaled with higher scores reflecting higher levels of acceptance.

Motivational regulation toward exercise. According to the Self-Determination Theory (SDT) (Deci & Ryan, 1985), human behaviors (including PA) are self-determined and to make a lasting change in behavior, this change needs to happen in an autonomous

way. Fortier, Sweet, O'Sullivan and Williams (2007) demonstrated this when they used the SDT as a guiding framework for an RCT in which they found that participants who reported higher levels of autonomous motivation 6 weeks into the intervention had higher levels of PA at the end of the 13-week intervention. Furthermore, Deci and Ryan (1985) also state that when an individual is more intrinsically motivated, then they are more autonomous. Ruffault et al. (2015) supported this assertion when they found that the interaction between intrinsic motivation and trait mindfulness was a significant predictor for PA level.

The Behavioral Regulation in Exercise Questionnaire - Revised (BREQ-II; Markland & Tobin, 2004). To assess the motivational regulation toward exercise, the BREQ-II was used. The BREQ-II is self-report questionnaire that assesses five subscales described by the SDT: external regulation, in which behavior is performed due to external demand or reward; introjected regulation, in which behavior is driven by self-control, protection of the ego, or internal rewards and punishments; identified regulation, in which behavior is somewhat internal and performed based on conscious values that are personally important; intrinsic regulation, in which an individual is self-motivated and self-determined, behaviors are performed based on interest, enjoyment, and satisfaction; and amotivation, which is a state characterized by lacking any intention to engage in a behavior and has no self-determination. Note that a measurement of integrated regulation is not included in the BREQ-II. This was due to the inability to differentiate between items related to identified regulation and integrated regulation, as well as items related to integrated regulation and intrinsic regulation.

According to the authors, the BREQ-II displays acceptable internal consistency for all factors. Cronbach's alpha reliabilities were as follows: external regulation = .79, introjected regulation = .80, identified regulation = .73, intrinsic regulation = .86, and amotivation = .83. Furthermore, their hypothesized model was not significantly difference from their original validation data (Satorra-Bentler Scaled χ^2= 136.49, [125], *p* = .23; CFI = .95; RMSEA = .02, 90% CI = .00 - .04; SRMR = .05).

The BREQ is composed of 19 items that assess the five subscales. Items 1, 6, 11, and 16 assess external regulation and consist of statements like, "I exercise because other people say I should." Items 2, 7, and 13 assess introjected regulation and consist of statements such as, "I feel ashamed when I miss an exercise session." Items 3, 8, 14, and 17 assess identified regulation and consist of statements similar to, "I think it is important to make the effort to exercise regularly." Items 4, 10, 15, and 18 assess internal regulation and consist of statements like, "I get pleasure and satisfaction from participating in exercise." Items 5, 9, 12, and 19 assess amotivation and consist of statements such as, "I think exercising is a waste of time." All items are scored on a 5-point Likert scale ranging from 0 ("not true for me") to 4 ("very true for me"). The BREQ-II can be scored in two different ways. The first is multidimensional scoring in which the scores for each set of items is average, giving a score for each dimension. The second method is a single score known as the Relative Autonomy Index (RAI) which was used in the logarithmic regression analysis. To score the RAI, a weighting of -3 was applied to scores from amotivation items (items 5, 9, 12, and 19), a weight of -2 were applied to scores for external regulation items (items 1, 6, 11, and 16), a weight of -1 was applied to the scores of introjected regulation items (items 2, 7, and 13), a weight of +1 was applied to the

scores of identified regulation items (items 3, 8, 14, and 17), and a weight of +2 was applied to the scores of all intrinsic regulation items (items 4, 10, 15, and 18). The final step in calculating the RAI is taking the sum of all weighted items. Higher, positive scores for the RAI indicated greater relative autonomy and lower, negative scored indicated more controlled regulation.

Exercise Intention. Exercise intention, based on an article by Courneya and McAuley (1993), can be conceptualized as the degree to which an individual has made conscious plans to exercise in the future. In order to assess this, three items described by Rhodes and Courneya (2003) were used. The first is a statement of "Over the next month, I intend exercise at least… times per week," rated on an open scale. The next item states, "In the next month my goal is to exercise…" to which participants can choose a rating on a 7-point Likert scale ranging from "1 – not at all" to "7 – every day." The final item states, "I intend to exercise at least every other day over the next month," and is rated on a 7-point Likert scale with responses ranging from "1 – strongly disagree" to "7 – strongly agree." Scores from the two fixed response items were averaged in order to obtain an average exercise intention score for the purposes of data analysis. There were no psychometric properties available to report for these items.

Perceived Stress. The idea of perceived stress was developed to enhance understanding of objective stress assessments, which tended to look at the frequency of stressful stimuli and emphasized specific events (e.g. divorce). Cohen, Kamarack, and Mermelstein (1983) argue that by focusing solely on objective measures of stress and ignoring the cognitive appraisal process, the model of human response to stress may not be complete. Instead, they support a model of stress that describes stress in terms of the

interplay between an individual's appraisal of a stressor (such as how severe the stressor is) and that individual's perceived ability to cope with the stressor.

Perceived Stress Scale -10 (PSS; Cohen, Kamarack, & Mermelstein, 1983). The PSS is a self-report measurement tool developed by Cohen et al. (1983) in order to assess the degree to which individuals perceived occurrences in their life as overly stressful relative to their perceived ability to cope with that stressful occurrence. Originally developed as a 14-item scale, Cohen and Williamson (1988) identified four poorly performing items and dropped them from the scale. Once removing these items, Cohen and Williamson (1988) report the scale as having acceptable internal consistency (alpha = .78). Chiu, Lu, Lin, Nein, Hsu, and Liu (2016) found an eight-day test-retest reliability of r= .66.

The PSS-10 is composed of 10 items that assess an individual's appraisal of stressors and their ability to cope with these stressors over the course of the previous month. The scale includes six negatively worded items (items 1, 2, 3, 6, 9, and 10) and includes statements such as, "In the last month, how often have you been upset because of something that happened unexpectedly?" Response options range from, "0 = Never" to "4 = Very Often." There are also four positively worded items (items 4, 5, 7, and 8) that include statements such as, "In the last month, how often have you felt confident about your ability to handle your personal problems?" Response options for these items remain the same as with the negative worded items. To score, the positively worded items are reverse scored (such that 0 = 4, 1 = 3, etc.) and then all item scores are summed with higher scores indicating higher perceived stress.

Moderate-to-Vigorous Physical Activity (MVPA). Moderate-intensity PA/exercise has been defined as activities that cause noticeable increases in heart rate and breathing (3 to 6 METs) and vigorous-intensity PA/exercise has been defined as activities that cause substantial increases in heart rate and breathing (greater than 6 METs). Thus, MVPA activities are those that require 3 METs or greater (Riebe et al., 2015).

International Physical Activity Questionnaire – Long Form (IPAQ; Craig et al., 2003). The IPAQ is a multi-dimensional self-report questionnaire developed by Craig et al. in 2003 for the purposes of assessing PA levels across many countries. The long form of the IPAQ addresses occupational, transport, housework, leisure time PA domains as well as an assessment of sitting time. Craig et al. (2003) report a pooled repeatability coefficient of $\rho = 0.81$ (95% CI 0.79–0.82). Overall, criterion validity with accelerometers was fair-to-moderate (pooled $\rho = 0.33$. 95% CI 0.26–0.39).

The complete long version of the IPAQ contains a total of 27 items. For the purposes of this study only items related to transportation PA (items 8 to 13), leisure time PA (items 20 to 25), and sitting time (items 26 and 27) were used. For both the transportation and the leisure time PA domains, participants were asked to report on PA bouts of at least 10 minutes. Using established scoring procedures (Di Blasio, Di Donato, & Mazzocco, 2010), activity bouts lasting longer than 180 minutes for transportation and leisure time PA were truncated and recoded to 180 minutes prior to calculating MET-minutes per week to avoid over-reporting of PA. Data were also cleaned for unrealistic sitting time estimates; we excluded anyone who reported more than 24 hours per day of sitting time and individuals who reported sitting time was more than 3 standard deviations above the mean.

We calculated several indices of PA for the purpose of our study. We created a summary variable for leisure time PA, which included responses to questions 22 through 25 from the long-form IPAQ, which assess moderate and vigorous intensity PA. We calculated MET-minutes per week for both moderate and vigorous activity and summed the two to obtain MET-minutes of leisure time moderate-to-vigorous PA per week. For moderate intensity activity MET-minutes per week were calculated by finding the total daily reported minutes of moderate intensity PA, multiplying by the reported amount of days in which moderate intensity PA was performed, and by multiplying by the MET value of four. Vigorous intensity MET-minutes per week were calculated by finding the total daily reported minutes of moderate intensity PA, multiplying by the reported amount of days in which moderate intensity PA was performed, and by multiplying by the MET value of eight. Recreational walking was considered as a standalone PA domain. It was calculated by calculating the total MET-minutes per week of walking done in leisure time. First, reported total daily minutes of leisure time walking was multiplied by the amount of days leisure walking was performed, and then was multiplied by the MET equivalent of 3.3. For transportation activity, we reported MET-minutes per week for cycling and walking for transportation as independent variables MET-minutes per week of cycling for transportation was calculated by finding the total daily minutes reported for cycling transport, multiplying by the number of days transport cycling was performed, and multiplying by the MET value of six. MET-minutes per week of walking for transpiration was calculated the same as cycling transportation except the corresponding Met value used was 3.3 METs. To determine if a person met the recommendations for PA, we only included leisure time moderate-to-vigorous PA.

Because mindfulness is most likely to be associated with intentional or purposeful activity, we limited meeting the recommendations to leisure time moderate-to-vigorous PA (MVPA). We defined meeting the recommendations as 450 MET-minutes per week of leisure time MVPA based on the ACSM Guidelines which recommend a minimum of 450 MET-minutes of moderate-to-vigorous physical per week (Garber et al., 2011).

Reported weekday and weekend sitting time minutes were also assessed in items 26 and 27 of the IPAQ. These variables were assessed simply by finding the total minutes spent sitting during a weekday and a weekend day.

Data Cleaning

The self-report data were obtained via an online web-based survey. Overall, a total of 184 participants responded to the survey. Of the 184, four survey responses were removed due to incompletion (two completed 2%, one completed 21%, and one completed 79%). Several responses for text entry items that required the respondent to type a number in a text box were spelled alphabetically rather than input numerically, these responses were changed to their corresponding numerical value. Additionally, several respondents answered the intention question regarding number of exercise sessions per week with a range instead of a single numerical value. For example, when asked how times they intended to exercise this week, some respondents answered, "3-4 times." All answers of this nature (n=7) were recoded to reflect the numerical midpoint of their response. Data were checked for outliers and values that were more than three standard deviations from the mean were recoded as missing data.

When computing the scores for the Mindful Attention and Awareness Scale, Item #13 and Item #14 were dropped from the survey due to these items being combined

resulting in a total of 13 items on this scale. Item #3 was also dropped from the Perceived Stress Scale because it was entered into the online survey as a duplicate of Item #2. This resulted in a total of nine items being summed for the PSS.

Multiple variables were recoded for the purposes of running logarithmic multiple regression analyses. First, the gender variable was changed so that the two responses "gender = other" were recoded as missing data. The ethnicity variable was recoded so that respondents who answered "prefer not to answer" were recoded as missing data. The race variable was recoded so that the small group sizes of respondents who answered "American Indian or Alaska Native," "Native Hawaiian or Other Pacific Islander," "Other," and "Prefer not to answer" were recoded to one category of "Other." The residence variable was recoded to a binary variable of living either on-campus or off-campus. The employment status variable was recoded so that respondents who answered that they worked either full- or part-time were recoded as "employed" and respondents who answered either "volunteer" or "non-employed" were recoded as "unemployed."

Next, due to highly non-normal data, the continuous variable of "moderate-to-vigorous PA" was recoded to either "meets PA recommendations" or "does not meet PA recommendations." A minimum of 450 MET-minutes per week was set as the minimum value for meeting the PA guidelines (Piercy et al., 2018). This value was calculated by summing the MET-minutes of moderate and vigorous PA reported by the participants. Due to extremely high collinearity, exercise intention items one and two (the 7-point Likert scale items) were combined to receive an average exercise intention score.

Data Analysis

All data were checked visually for outliers. Data was also be assessed for normality prior to analysis using the Kolmogorov-Smirnov test (assuming a sample size of at least 50 participants), by examining the skewness and kurtosis, and by examining normality plots. Data were examined visually for outliers and data points (greater than 3 SD from the mean). Means and SD, medians and interquartile range, or frequencies and percentages were presented for subject characteristics and key variables (i.e. MAAS, PHLMS, BREQ-II, Intention, PSS, and IPAQ scores). For parametric data, Pearson product-moment correlation coefficients were used to indicate the size and direction of the relationships between the variables. For nonparametric data, Spearman rank correlation coefficients were used. A logistic regression analysis was conducted to examine if mindfulness is independently associated with meeting the PA recommendations. Categorical variables were coded as dummy variables prior to the logistic regression analyses. The Hosmer-Lemeshow Goodness of Fit and the Nagelkerke R^2 were examined to assess goodness of fit. All statistical analyses were performed in SPSS version 24 (IBM, Armonk, NY). Significance level was set at $\alpha = 0.05$.

CHAPTER 4

RESULTS

This study used a cross-sectional design for the primary purpose of exploring the relationships among trait mindfulness, self-reported PA levels, behavioral regulation toward exercise, exercise intention, and perceived stress in undergraduate university students, both males and females.

Participant Characteristics

Sample demographic information is available in Table 1. Participants were undergraduate students (n =180) recruited from a large southwestern metropolitan university. Participant ages ranged from 18 to 24 years old with the largest proportion of the sample aged 21 (n = 40, 23.0%). Participants were predominantly Caucasian (n = 115, 63.9%), non-Hispanic (n = 135, 75.0%), and female (n = 140, 77.8%). Most participants attended the Tempe campus (n = 107, 59.8%), were in their Junior year of college (n = 60, 33.5%), lived off campus (n = 134, 74.4%), and were employed (n = 133, 73.9%). Most participants responded that they did participate in structured PA during high school (n = 131, 72.8%). Only 36 (20.0%) of the participants reported past mediation experience. A summary of research variables stratified by gender is available in Table 2. There were no significant differences between males and females for mindfulness scores, BREQ-II scores, exercise intention, PSS scores, leisure time MVPA, or sitting time. A total of 106 (58.9%) participants met the recommended PA guidelines of a minimum of 450 MET-minutes of leisure-time MVPA per week.

TABLE 1. Participant demographics.

	Whole Sample (n = 180)	Males (n = 38)	Females (n = 140)	Other (n = 2)
Age, *n* (%)				
18 years	17 (9.8)	3 (8.1)	14 (10.4)	0 (0)
19 years	32 (18.4)	5 (13.5)	27 (20.0)	0 (0)
20 years	36 (20.7)	10 (27.0)	26 (19.3)	0 (0)
21 years	40 (23.0)	10 (27.0)	30 (22.2)	0 (0)
22 years	17 (9.8)	3 (8.1)	14 (10.4)	0 (0)
23 years	19 (10.9)	4 (10.8)	13 (9.6)	2 (100.0)
24 years	13 (7.5)	2 (5.4)	11 (8.1)	0 (0)
Hispanic ethnicity, *n* (%)				
Yes	44 (24.4)	8 (21.1)	36 (25.7)	0 (0)
No	135 (75.0)	30 (78.9)	103 (73.6)	2 (100.0)
Prefer not to answer	1 (0.6)	0 (0)	1 (0.7)	0 (0)
Race, *n* (%)				
American Indian or Alaskan Native	5 (2.8)	0 (0)	5 (3.6)	0 (0)
Asian	23 (12.8)	7 (18.4)	16 (11.4)	0 (0)
Black or African American	11 (6.1)	2 (5.3)	9 (6.4)	0 (0)
Native Hawaiian or Other Pacific Islander	4 (2.2)	1 (2.6)	0 (0)	0 (0)
White	115 (63.9)	24 (63.2)	89 (63.3)	2 (100.0)
Other	18 (10.0)	3 (7.9)	15 (10.7)	0 (0)
Prefer not to answer	4 (2.2)	1 (2.6)	3 (2.1)	0 (0)
Acedemic year, *n* (%)				
First Year	39 (21.8)	7 (18.4)	31 (22.3)	1 (50.0)
Sophmore	33 (18.4)	9 (23.7)	24 (17.3)	0 (0)
Junior	60 (33.5)	8 (21.1)	51 (36.7)	1 (50.0)
Senior	45 (25.1)	12 (31.6)	33 (23.7)	0 (0)
Post-Bac	2 (1.1)	2 (5.3)	0 (0)	0 (0)

TABLE 1. Continued

	Whole Sample (n = 180)	Males (n = 38)	Females (n = 140)	Other (n = 2)
Campus, *n* (%				
Tempe	107 (59.8)	29 (76.3)	77 (55.4)	1 (50.0)
Downtown Phoenix	28 (15.6)	5 (13.2)	23 (16.5)	0 (0)
West	13 (7.3)	1 (2.6)	12 (8.6)	0 (0)
Polytechnic	3 (1.7)	0 (0)	3 (2.2)	0 (0)
Exclusively Online	28 (15.6)	3 (7.9)	24 (17.3)	1 (50.0)
Residence, *n* (%)				
ASU Residence Hall/Dormatory	46 (25.6)	8 (21.1)	38 (27.1)	0 (0)
Off Campus, with Parents or Family	50 (27.8)	9 (23.7)	41 (29.3)	0 (0)
Off Campus, with Roommates	52 (28.9)	16 (42.1)	34 (24.3)	2 (100.0)
Off Campus, Live Alone	24 (13.3)	4 (10.5)	20 (14.3)	0 (0)
Other	8 (4.4)	1 (2.6)	7 (5.0)	0 (0)
Employment status, *n* (%)				
Full-time	36 (20.0)	7 (18.4)	29 (20.7)	0 (0)
Part-time	97 (53.9)	19 (50.0)	77 (55.0)	1 (50.0)
Volunteer	7 (3.9)	3 (7.9)	3 (2.1)	1 (50.0)
Non-employed	40 (22.2)	9 (23.7)	31 (22.1)	0 (0)
Meditation experience, *n* (%)				
Yes	36 (20.0)	9 (23.7)	27 (19.3)	0 (0)
No	144 (80.0)	29 (76.3)	113 (80.7)	2 (100.0)
Past experience with structured physical activity, *n* (%)				
Yes	131 (72.8)	32 (84.2)	99 (70.7)	0 (0)
No	49 (27.2)	6 (15.8)	41 (29.3)	2 (100.0)

TABLE 2. Summary of research variables.

	Total (n = 180)	**Males (n = 38)**	**Females (n = 140)**	**Other (n =2)**
	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]
MAAS	3.85 ± .93	3.98 ± .99	3.67 ± .90	2.73 ± .59
PHLMS				
Awareness	35.5 ± 6.3	36.4 ± 7.4	35.3 ± 6.0	–
Acceptance	27.7 ± 7.6	28.8 ± 8.5	27.3 ± 7.4	28.0 ± 1.4
BREQ-II				
Amotivation	0.00 [0.31]	0.00 [0.44]	0.00 [0.25]	0.75 [–]
External regulation	0.50 [1.50]	0.25 [1.25]	0.50 [1.50]	0.88 [.25]
Introjected regulation	2.07 ± 1.2	2.12 ± 1.1	2.09 ± 1.2	0.33 ± .47
Identified regulation	3.00 [1.50]	3.00 [1.19]	3.00 [1.67]	2.25 [–]
Intrinsic regulation	3.00 [1.75]	3.00 [1.94]	3.00 [1.75]	2.38 [1.94]
Relative Autonomy Index (RAI)	10.7 [9.56]	11.0 [10.4]	10.7 [9.46]	7.29 [–]
Perceived Stress Scale (PSS)	17.1 ± 6.9	16.2 ± 7.4	17.4 ± 6.8	20.0 ± 7.1
Exercise intention				
"My goal is to exercise…"	5.05 ± 1.3	5.18 ± 1.3	5.03 ± 1.3	–
"I intend to exercise at least every other day."	6.00 [3.00]	6.00 [3.0]	6.00 [3.0]	3.50 [–]
Average Exercise Intention	5.50 [2.50]	5.50 [2.13]	5.50 [2.50]	3.75 [–]

IQR = Interquartile range; SD = Standard deviation

– Denotes incomplete, missing, or insufficient data for analyses.

TABLE 2. Summary of research variables (cont.).

	Total (n = 180)	**Males (n = 38)**	**Females (n = 140)**	**Other (n =2)**
	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]	Mean ± SD or Median [IQR]
Physical activity, MET-minutess/week				
Cycling transport	0.00 [0.00]	0.00 [360]	0.00 [0.00]	–
Walking transport	792.0 [1423.1]	990.0 [1881.0]	742.5 [1460.3]	594.0 [–]
Recreational walking	198.0 [693.0]	99.0 [445.5]	198.0 [792.0]	–
Moderate-intensity	0.00 [480.0]	0.00 [450.0]	0.00 [700.0]	–
Vigorous-intensity	480.0 [1920.0]	660.0 [3360.0]	480.0 [1620.0]	–
Leisure time MVPA	940.0 [2550.0]	940.0 [3090.0]	960.0 [2490.0]	–
Meeting PA guidelines, *n* (%)				
Yes	106 (58.9)	26 (68.4)	80 (57.1)	0 (0)
No	74 (41.1)	12 (31.6)	60 (42.9)	2 (100)
Sitting time, mins				
Weekday	360.0 [240.0]	360.0 [288.8]	360.0 [240.0]	240.0 [–]
Weekend	360.0 [187.3]	360.0 [262.5]	360.0 [240.0]	300.0 [–]

IQR = Interquartile range; SD = Standard deviation

– Denotes incomplete, missing, or insufficient data for analyses.

Bivariate Associations

Leisure time moderate-to-vigorous intensity and recreational walking physical activity. Correlations for leisure time MVPA and recreational walking MET-minutes per week are available in Table 3. Introjected regulation (ρ =.236, p < .01), identified regulation (ρ =.563, p < .01), intrinsic regulation (ρ = .514, p < .01), relative autonomy index (ρ = .449, p < .01), awareness (ρ = .168, p < .05), average exercise intention (ρ = .565, p < .01) were positively associated with MET-minutes per week of leisure time MVPA. Amotivation (ρ = –.229, p < .01) and perceived stress (ρ = –.178, p < .05) were negatively associated with MET-minutes per week of leisure time MVPA. Identified regulation (ρ = .160, p < .05), intrinsic regulation (ρ = .147, p < .05), and awareness (ρ = .203, p < .05) were positively associated with MET-minutes per week of recreational walking.

Transport physical activity. Correlations for walking and cycling transportation PA are presented in Table 4. Only perceived stress (ρ = –.149, p < .05) was negatively associated with MET-minutes per week of cycling transportation.

Sitting time. Correlations for sitting time are presented in Table 5. Amotivation (ρ = .188, p < .05), perceived stress (ρ = .205, p < .01), and weekend sitting time (ρ = .616, p < .01) were positively associated with weekday sitting time. External regulation (ρ = .162, p < .05) and perceived stress (ρ = .186, p < .05) were positively associated with weekend sitting time. Identified regulation (ρ = –.190, p < .05), intrinsic regulation (ρ = –.240, p < .01), relative autonomy index (ρ = –.235, p < .01), MAAS score (ρ = –.238, p < .01), acceptance (ρ = –.175, p < .05), and average exercise intention (ρ = –.194,

$p < .05$) were negatively associated with weekday sitting time. Identified regulation ($\rho = -.295$, $p < .01$), intrinsic regulation ($\rho = -.322$, $p < .01$), relative autonomy index ($\rho = -.314$, $p < .01$), MAAS score ($\rho = -.197$, $p < .01$), acceptance ($\rho = -.181$, $p < .05$), and average exercise intention ($\rho = -.190$, $p < .05$) were negatively associated with weekend sitting time.

Independent Variables. Correlations for all other independent variables are presented in Table 3. For parametric data, Pearson product-moment correlation coefficients (r) were used to indicate the size and direction of the relationships between the variables. For nonparametric data, Spearman rank correlation coefficients (ρ) were used.

Trait mindfulness associations. Trait mindfulness, as assessed using the MAAS, was positively associated with intrinsic regulation ($\rho = .191$, $p < .05$), relative autonomy ($\rho = .301$, $p < .01$), awareness ($r = .367$, $p < .01$), and acceptance ($r = .390$, $p < .01$). It was also negatively associated with amotivation ($\rho = -.178$, $p < .05$), external regulation ($\rho = -.272$, $p < .01$), introjected regulation ($r = -.342$ $p < .01$, and stress ($r = -.577$, $p < .01$). Associations for the PHLMS are as follows: awareness was positively associated with identified regulation ($\rho = .323$, $p < .01$), intrinsic regulation ($\rho = .282$, $p < .01$), relative autonomy ($\rho = .333$, $p < .01$), and intention ($\rho = .260$, $p < .01$). Awareness was negatively associated with amotivation ($\rho = -.220$, $p < .01$), external regulation ($\rho = -.163$, $p < .05$), and stress ($r = -.293$, $p < .01$). Acceptance was positively associated with relative autonomy ($\rho = .192$, $p < .05$) and negatively associated with external regulation

(ρ = –.216, p < .01), introjected regulation (r = –.330, p < .01), and stress (ρ = –.572, p < .01).

Other associations. Amotivation was negatively associated with exercise intention (ρ = –.436, p < .01). External regulation was positively associated with stress (ρ = .240, p < .01) and negatively associated with intention (ρ = –.153, p < .05). Introjected regulation was positively associated with stress (r = .383, p < .01) and exercise intention (ρ = .301, p < .01). Identified regulation was positively associated with exercise intention (ρ = .725, p < .01). Intrinsic regulation was positively associated with exercise intention (ρ = .583, p < .01) and was negatively associated with stress (ρ = –.161, p < .05). Relative autonomy was positively associated with exercise intention (ρ = .536, p < .01) and negatively associated with stress (ρ = –.268, p < .01).

TABLE 3. Leisure time physical activity correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Amotivation	1	.319** (n = 180)	–.095 (n = 180)	–.468** (n = 180)	–.469** (n = 180)	–.638** (n = 180)	–.178* (n = 180)	–.220** (n = 176)	–.097 (n = 180)	.117 (n = 180)	–.436** (n = 179)	–.065 (n = 179)	–.229** (n = 180)
2. External Regulation		1	.224** (n = 180)	–.190* (n = 180)	–.368** (n = 180)	–.641** (n =180)	–.272** (n = 180)	–.163* (n = 176)	–.216** (n = 180)	.240** (n = 180)	–.153* (n = 179)	–.010 (n = 179)	–.133 (n = 180)
3. Introjected Regulation			1	.391** (n = 180)	.160* (n = 180)	–.047 (n = 180)	**–.342** (n = 180)**	**.014 (n = 176)**	**–.330** (n = 180)**	**.383** (n = 180)**	.301** (n = 179)	–.022 (n = 179)	.236** (n = 180)
4. Identified Regulation				1	.727** (n = 180)	.706** (n =180)	.036 (n = 180)	.323** (n = 176)	.014 (n = 180)	–.082 (n = 180)	.725** (n = 179)	.160* (n = 179)	.563** (n = 180)
5. Intrinsic Regulation					1	.880** (n = 180)	.191* (n = 180)	.282** (n = 176)	.061 (n = 180)	–.161* (n = 180)	.583** (n = 179)	.147* (n = 179)	.514** (n = 180)
6. Realative Autonomy Index						1	.301** (n = 180)	.333** (n = 176)	.192* (n = 180)	–.268** (n = 180)	.563** (179)	.139 (n = 179)	.449** (n = 180)
7. MAAS Score							1	**.367** (n = 176)**	**.390** (n = 180)**	**–.577** (n = 180)**	.070 (n = 179)	.190* (n = 179)	.110 (n = 180)
8. Awareness Score								1	**.068 (n = 176)**	**–.293** (n = 176)**	.260** (n = 175)	.203** (n = 175)	.168* (n = 176)
9. Acceptance Score									1	**–.572** (n = 180)**	.019 (n = 179)	.073 (n = 179)	.066 (n = 180)
10. Stress Score										1	–.121 (n = 180)	–0.137 (n = 179)	–.178* (n = 180)
11. Avg. Exercise Intention											1	.085 (n = 178)	.565** (n = 180)
12. Recreation Walking												1	.290** (n = 179)
13. MVPA													1

Note. All correlations are presented in Spearman's rho unless otherwise noted.

Bold. Correlation coefficient presented is Pearson's *r*.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

TABLE 4. Transportation physical activity correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Amotivation	1	.319** (n = 180)	–.095 (n = 180)	–.468** (n = 180)	–.469** (n = 180)	–.638** (n = 180)	–.178* (n = 180)	–.220** (n = 176)	–.097 (n = 180)	.117 (n = 180)	–.436** (n = 179)	.004 (n = 180)	–.020 (n = 180)
2. External Regulation		1	.224** (n = 180)	–.190* (n = 180)	–.368** (n = 180)	–.641** (n =180)	–.272** (n = 180)	–.163* (n = 176)	–.216** (n = 180)	.240** (n = 180)	–.153* (n = 179)	.020 (n = 180)	.052 (n = 180)
3. Introjected Regulation			1	.391** (n = 180)	.160* (n = 180)	–.047 (n = 180)	**–.342** (n = 180)**	**.014 (n = 176)**	**–.330** (n = 180)**	**.383** (n = 180)**	.301** (n = 179)	.103 (n = 180)	.055 (n = 180)
4. Identified Regulation				1	.727** (n = 180)	.706** (n =180)	.036 (n = 180)	.323** (n = 176)	.014 (n = 180)	–.082 (n = 180)	.725** (n = 179)	.122 (n = 180)	.116 (n = 180)
5. Intrinsic Regulation					1	.880** (n = 180)	.191* (n = 180)	.282** (n = 176)	.061 (n = 180)	–.161* (n = 180)	.583** (n = 179)	.135 (n = 180)	.115 (n = 180)
6. Realative Autonomy Index						1	.301** (n = 180)	.333** (n = 176)	.192* (n = 180)	–.268** (n = 180)	.563** (179)	.061 (n = 180)	.062 (n = 180)
7. MAAS Score							1	**.367** (n = 176)**	**.390** (n = 180)**	**–.577** (n = 180)**	.070 (n = 179)	.044 (n = 180)	.063 (n = 180)
8. Awareness Score								1	**.068 (n = 176)**	**–.293** (n = 176)**	.260** (n = 175)	.065 (n = 176)	.029 (n = 176)
9. Acceptance Score									1	**–.572** (n = 180)**	.019 (n = 179)	–.141 (n = 180)	.136 (n = 180)
10. Stress Score										1	–.121 (n = 180)	.062 (n = 180)	–.149* (n = 180)
11. Avg. Exercise Intention											1	.011 (n = 179)	.120 (n = 179)
12. Walking Transportation												1	–.038 (n = 179)
13. Cycling Transportation													1

Note. All correlations are presented in Spearman's rho unless otherwise noted.

Bold. Correlation coefficient presented is Pearson's *r*.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

TABLE 5. Sitting time correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Amotivation	1	.319** (n = 180)	–.095 (n = 180)	–.468** (n = 180)	–.469** (n = 180)	–.638** (n = 180)	–.178* (n = 180)	–.220** (n = 176)	–.097 (n = 180)	.117 (n = 180)	–.436** (n = 179)	.188* (n = 169)	.091 (n = 174)
2. External Regulation		1	.224** (n = 180)	–.190* (n = 180)	–.368** (n = 180)	–.641** (n =180)	–.272** (n = 180)	–.163* (n = 176)	–.216** (n = 180)	.240** (n = 180)	–.153* (n = 179)	.046 (n = 169)	.162* (n = 174)
3. Introjected Regulation			1	.391** (n = 180)	.160* (n = 180)	–.047 (n = 180)	**–.342** (n = 180)**	**.014 (n = 176)**	**–.330** (n = 180)**	**.383** (n = 180)**	.301** (n = 179)	.008 (n = 169)	–.002 (n = 174)
4. Identified Regulation				1	.727** (n = 180)	.706** (n =180)	.036 (n = 180)	.323** (n = 176)	.014 (n = 180)	–.082 (n = 180)	.725** (n = 179)	–.190* (n = 169)	–.295** (n = 174)
5. Intrinsic Regulation					1	.880** (n = 180)	.191* (n = 180)	.282** (n = 176)	.061 (n = 180)	–.161* (n = 180)	.583** (n = 179)	–.240** (n = 169)	–.322** (n = 174)
6. Realative Autonomy Index						1	.301** (n = 180)	.333** (n = 176)	.192* (n = 180)	–.268** (n = 180)	.563** (179)	–.235** (n = 169)	–.314** (n = 174)
7. MAAS Score							1	**.367** (n = 176)**	**.390** (n = 180)**	**–.577** (n = 180)**	.070 (n = 179)	–.238** (n = 169)	–.197** (n = 174)
8. Awareness Score								1	**.068 (n = 176)**	**–.293** (n = 176)**	.260** (n = 175)	–.115 (n = 165)	–.137 (n = 170)
9. Acceptance Score									1	**–.572** (n = 180)**	.019 (n = 179)	–.175* (n = 169)	–.181* (n = 174)
10. Stress Score										1	–.121 (n = 180)	.205** (n = 169)	.186* (n = 174)
11. Avg. Exercise Intention											1	–.194* (n = 168)	–.190* (n = 173)
12. Weekday Sitting Time												1	.616** (n = 168)
13. Weekend Sitting Time													1

Note. All correlations are presented in Spearman's rho unless otherwise noted.

Bold. Correlation coefficient presented is Pearson's *r*.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Logistic Regression Analysis

Table 6 displays the full output of the logistic regression. Results of the logistic regression indicated that relative autonomy index (OR = 1.085, 95% CI [1.008, 1.168], p = .030) and average exercise intention (OR = 2.193, 95% CI [1.533, 3.138], $p < .0001$) were significant independent associations with meeting weekly PA recommendations. For every one-point increase in relative autonomy, the odds that an individual meets the weekly PA recommendations increases 8.5%. For every one-point increase in average exercise intention, the odds that an individual meets the weekly PA recommendations increases by 219.3%. No other variables were associated with meeting the PA recommendations. The Nagelekerke R^2 for the full model was 50.1%.

TABLE 6. Logistic Regression Analysis for Meeting Weekly PA Guidelines[a]

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Gender								
Male						1.000		
Female	0.336	0.527	0.406	1	0.524	1.400	0.498	3.935
Race			4.236	3	0.237			
Caucasian						1.000		
Other	-0.483	0.624	0.597	1	0.440	0.617	0.181	2.098
Asian	-1.217	0.631	3.715	1	0.054	0.296	0.086	1.021
Black or African American	-0.754	0.917	0.676	1	0.411	0.471	0.078	2.841
Ethnicity								
Hispanic						1.000		
Non-Hispantic	-0.467	0.571	0.667	1	0.414	0.627	0.205	1.921
Residence								
On-Campus						1.000		
Off Campus	0.111	0.493	0.051	1	0.821	1.118	0.425	2.937
Employment Status								
Employed						1.000		
Unemployed	0.466	0.472	0.976	1	0.323	1.594	0.632	4.023
Patricipation in structured PA during high school								
Yes						1.000		
No	-0.891	0.461	3.735	1	0.053	0.410	0.166	1.013
Awareness	-0.021	0.039	0.285	1	0.593	0.980	0.908	1.057
Acceptance	0.019	0.034	0.311	1	0.577	1.019	0.953	1.090
MAAS	-0.027	0.299	0.008	1	0.929	0.974	0.542	1.750
PSS	-0.033	0.042	0.628	1	0.428	0.967	0.890	1.051
RAI	**0.081**	**0.038**	**4.698**	**1**	**0.030**	**1.085**	**1.008**	**1.168**
Average Exercise Intention	**0.785**	**0.183**	**18.454**	**1**	**0.000**	**2.193**	**1.533**	**3.138**
Constant	-2.885	2.465	1.369	1	0.242	0.056		

Bold - statistically significant predictor of meeting or not meeting PA recommendations.

a - 450 MET-minutes per week (Garber et al., 2011)

CHAPTER 5

DISCUSSION

There were two primary aims of this study. The first explored the associations between trait mindfulness, self-reported PA, behavioral regulation toward exercise, exercise intention, and perceived stress. The second examined if trait mindfulness was independently associated with meeting weekly PA recommendations after controlling for demographic characteristics, past PA experience, stress, exercise intention, and motivation. In a sample of university undergraduate students, leisure time MVPA was only modestly associated with the awareness domain of trait mindfulness (as assessed by the PHLMS), but was not associated with the acceptance domain or the MAAS. These results are not surprising as previous research has demonstrated either a very weak, or a non-significant direct association between trait mindfulness and PA (Chatzisarantis & Haggar, 2007; Gilbert & Waltz, 2010; Roberts & Danoff-Berg, 2010; Ruffault et al., 2015; Tsafou et al., 2016; and Tsafou et al., 2017). Additionally, the results of the logistic regression analysis revealed that relative autonomy and exercise intention were the only significant independent associations with meeting the weekly PA guidelines in the present model. Again, these findings are in alignment with previous research. Frist, Chatzisarantis and Haggar (2007) determined that intention to exercise, and not trait mindfulness, was moderately associated with PA in the positive direction. Second, results from Ruffault et al. (2015) show that the greatest predictor for PA was intrinsic regulation (a highly autonomous form of regulation).

The present study is unique in three distinct ways. First, while previous research has explored the relationship between trait mindfulness and PA in the context of

motivation, intention, or stress separately, the present study accounted for these variables at the same time. Second, the present study included assessment of not only intentional, leisure time PA, but also transport PA. Third, the present study also assessed sitting time in conjunction with other domains of PA.

While the results of this study found only weak associations between mindfulness and intentional PA, it did not find any significant associations with transportation PA. This potentially adds validity to our findings as mindfulness may be more likely to influence intentional or volitional behaviors. Transport PA may be a result of necessity rather than choice. Relative autonomy was independently associated with meeting PA recommendations, suggesting choice is an important factor in PA participation. Trait mindfulness, awareness, and acceptance were all positively associated with relative autonomy, suggesting mindfulness may influence PA indirectly through relative autonomy.

Potential mechanisms through which mindfulness influences PA are autonomy and stress. Past research has demonstrated that mindfulness is positively associated with factors that are indicative of higher autonomy such as enjoyment, satisfaction, and intrinsic motivation (Ruffault et al, 2016; Tsafou et al., 2016; Tsafou et al., 2017; Cox et al., 2018). People are more likely to engage in health behaviors (e.g. PA) when they are autonomous (Deci & Ryan, 1985; Fortier et al., 2007). Deci and Ryan established the two main factors that increase autonomy are satisfaction (or enjoyment) and achievement of goals. Tasfou et al. (2016; 2017) demonstrated satisfaction mediated the relationship of mindfulness and PA. Similarly, Cox et al. (2018) demonstrated participants in a mindful state perceived they were working less strenuously during exercise and had higher

enjoyment of PA relative to a distraction control condition. According to Shapiro and colleague's (2006) model of mindfulness, one of the mechanisms through which mindfulness enables behavior is by allowing individuals to better recognize and act upon their own inherent values. Findings from the present study are consistent with these studies. Mindfulness was positively (*r* ranging from 0.192 to 0.333) associated autonomy and autonomy and intention were both independently associated with meeting the leisure time PA recommendations in multivariable logistic regression analyses. Likewise, mindfulness and relative autonomy were also both negatively associated with sitting time. We may find a potential explanation of this association in previous studies. Findings from Brown and Ryan (2003) as well as Fortier et al. (2007) Suggest that those who are more mindful and autonomous may be more conscientious of their PA goals and act in accordance with, resulting in decreased sedentary behavior.

Another potential way through which mindfulness influences PA is through the reduction of stress. Mindfulness is consistently supported as an effective tool for stress reduction (Khoury et al., 2015; Gotink et al., 2015). In our study, trait mindfulness, awareness and acceptance were all negatively associated with perceived stress and perceived stress was negatively associated with leisure time moderate-to-vigorous PA in bivariate associations. However, neither mindfulness nor stress were independently associated of meeting PA recommendations in logistic regression models that included relative autonomy and intention. This is in contrast to two previous cross-sectional studies that demonstrated mindfulness is related to decreased stress levels, which in turn lead to increased levels of PA (Roberts & Danoff-Burg, 2010; Sagui-Henson, Levens, & Blevins, 2018). To date, there have not been any experimental studies examining stress as

a mediator between mindfulness interventions and PA participation. More research is warranted to examine how stress mediates the relationship between mindfulness and PA.

There are several limitations to the present study. The present study used a cross-sectional design. Therefore, inferences of causality cannot be made. Selection bias is a second limitation of this study. Our data show that nearly 58.9% of the sample reported regular participation in exercise. National data suggest 45.1% of college students meet the recommendations for PA (American College Health Association, 2018). The differences between the study sample and the larger population may suggest that physically active individuals were more likely to participate than physically inactive individuals. This study is also limited by the small sample size and self-reported assessments of study variables. The use of self-reported data is a potential limitation because participants may have responded with answers they perceived to be socially desirable or may not have chosen accurate answers due to flawed recall. One final potential limitation was the high correlation between the two significant independent associations with meeting weekly PA guidelines, relative autonomy and exercise intention. While the analysis determined that the collinearity of these factors was not significant, it may have had an influence on the results.

Despite these limitations, there a few strengths present in this study. First of all, and to the best of our knowledge, this was the first study to explore the association between mindfulness and PA while controlling for motivation, exercise intention, and stress. Other strengths present in this study are the ethnically diverse sample, the use of validated measures to assess research variables, and the fact that we included only

college-aged (18-24 years) individuals allowed the results of this study to be highly applicable to our target demographic.

Conclusion

Overall, the results of this study demonstrate that mindfulness may be an important consideration in the promotion of PA. Findings from this study suggest trait mindfulness is moderately associated with stress and modestly associated with both relative autonomy and MET-minutes of moderate- to- vigorous PA. Awareness and acceptance are modestly associated with both relative autonomy and stress but only awareness was modestly associated with intention and MET-minutes of leisure time moderate-to-vigorous PA. However, in multivariate models, only exercise intention and relative autonomy are independently associated with PA potentially suggesting intention and/or autonomy are the potential mechanisms through which mindfulness exerts its influence. Additional longitudinal or intervention research is necessary to understand the mechanisms through which mindfulness influences PA. Overall, the results of this study demonstrate the potential that mindfulness has for the promotion of PA.

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APPENDIX A

LETTER OF IRB APPROVAL

Vinson Napolitano <vnapolit@asu.edu>

STUDY00009603 has been approved

1 message

research.integrity@asu.edu <research.integrity@asu.edu> Wed, Feb 13, 2019 at 10:18 AM
Reply-To: research.integrity@asu.edu
To: Vinson.Napolitano@asu.edu

Template:IRB_T_Post-Review_Approved

Notification of Approval

To:	Vinson Napolitano
Link:	STUDY00009603
P.I.:	Cheryl Der Ananian
Title:	Mindfulness and Physical Activity
Description:	This submission has been approved. You can access the correspondence letter using the following link: Correspondence_for_STUDY00009603.pdf(0.01) To review additional details, click the link above to access the project workspace.

APPENDIX B

LETTER OF INFORMED CONSENT

Short Consent Template

A Cross-Sectional Examination of the Relationship Between Trait Mindfulness, Physical Activity, Intrinsic Motivation to Exercise, Exercise Intention, and Perceived Stress in University Undergraduates.

My name is Vinson Napolitano, I am a graduate student under the direction of Associate Professor, Cheryl Der Ananian, in the Exercise Science and Health Promotion Program, College of Health Solutions at Arizona State University. I am conducting a research study to examine the relationships between mindfulness, physical activity, stress, intention to participate in exercise, and motivation to exercise in undergraduate students at Arizona State University.

I am inviting your participation in this study because you have met the eligibility requirements to be part of this study. You will be asked to complete series of online surveys that are anticipated take 30 minutes to complete. Once the survey is completed and submitted your obligation to the research will be complete. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You may be eligible to receive a $10 e-gift card from Amazon.com for completing the survey; the first 150 people to complete the survey will be eligible to receive an e-gift card. At the end of the survey you will have the option to provide name and an email address for the purpose of receiving their incentive. If the you do not want to provide your name and email address, an email address to contact the study directly will be provided. The e-gift card will be emailed to the address provided. All names and email addresses collected will be removed from the data file once the electronic gift card has been sent. You must be 18 to 24 years old and an undergraduate student at Arizona State University to participate in the study.

There is no direct benefit to you for your participation in this study. There are no foreseeable risks or discomforts to your participation.

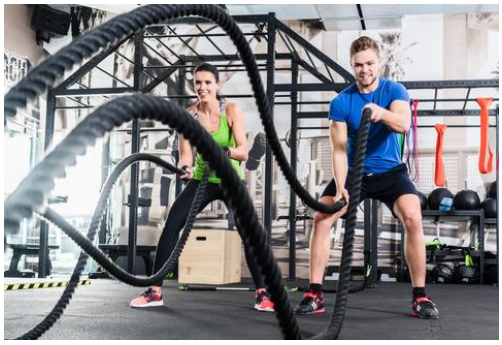
All responses will be confidential. The IP address collection option has been turned off in the survey software as an extra layer of protection. Survey results will be stored in a secure electronic file on a secured computer in the Arizona Biomedical Center at Arizona State University. Only the researchers directly involved in this study will have access to the files. The results of this study may be used in reports, presentations, or publications but individual names will not be used. In any sort of report we make public, all reports will be shared in the aggregate form.

If you have any questions concerning the research study, please contact the research team at: Vinson Napolitano at vnapolit@asu.edu, or Cheryl Der Ananian at Cheryld@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

By completing the survey, you agree to participate in the study. If you do not want to participate, please exit the survey now.

APPENDIX C

RECRUITMENT MATERIALS



College of Health Solutions
Arizona State University

Participants Needed for a Study Investigating Mindfulness and Exercise.

We are currently recruiting undergraduate students (ages 18 to 24) for a study investigating the link between mindfulness and exercise. You do not have to exercise to participate.

What is required for this study?

Should you qualify for this study, all that we will ask of you is to fill out a one-time survey that pertains to mindfulness, exercise, and attitudes toward exercise. This survey should only take **30 minutes** to complete and can be completed from either a computer or mobile device. As a thank you for your participation in this study, the first 150 participants who complete the questionnaire will receive a **$10 electronic gift card to Amazon.com.**

If you are interested, please fill out our screening questionnaire to see if you qualify to participate in this study. This survey should take less than five minutes to complete and can be accessed scanning the QR Code (SnapChat has a built-in reader):

or
emailing the investigators at
MindfulnessPAStudy.asu@gmail.com

For more information please contact Vinson Napolitano at MindfulnessPAStudy.asu@gmail.com

Your participation in this study is completely voluntary and your information will be kept confidential.

ASU IRB IRB # STUDY00009603 | Approval Period 2/13/2019

ASU Mindfulness and Exercise Study
MindfulnessPAStudy.asu@gmail.com

ASU Mindfulness and Exercise Study
MindfulnessPAStudy.asu@gmail.com
ASU Mindfulness and Exercise Study
MindfulnessPAStudy.asu@gmail.com
ASU Mindfulness and Exercise Study
MindfulnessPAStudy.asu@gmail.com
ASU Mindfulness and Exercise Study
MindfulnessPAStudy.asu@gmail.com

Press Release/Email script

The College of Health Solutions at Arizona State University is conducting a research study to look at the relationship between mindfulness and exercise in college students. We are currently recruiting undergraduate students (ages 18 to 24) and you do not have to exercise to participate.

What is required for this study?

Should you qualify for this study, all that we will ask of you is to fill out a one-time survey that pertains to mindfulness, exercise, and attitudes toward exercise. This survey should only take around **30 minutes** to complete and can be completed from either a computer or mobile device. As a thank you for your participation in this study, the first 150 participants who complete the questionnaire will receive a **$10 electronic gift card to Amazon.com.**

If you are interested, please fill out our screening questionnaire to see if you qualify to participate in this study. This survey should take less than five minutes to complete and can be accessed by visiting the following link:

Mindfulness and Physical Activity Study

or

by emailing the investigators at **MindfulnessPAStudy.asu@gmail.com**

For more information please contact Vinson Napolitano at asu.mindfulness@gmail.com

Your participation in this study is completely voluntary and your information will be kept confidential.

For more information, please contact Vinson Napolitano at **MindfulnessPAStudy.asu@gmail.com** .

Thank you!

ASU Knowledge Enterprise Development

ASU IRB IRB # STUDY00009603 | Approval Period 2/13/2019

APPENDIX D

SCREENING QUESTIONNAIRE

Screening Questionnaire

Start of Block: Mindfulness and Physical Activity Screener

Q1 The College of Health Solutions at Arizona State University is conducting a research study to look at the relationship between mindfulness and exercise in college students. We are currently recruiting undergraduate students (ages 18 to 24) and you do not have to exercise to participate. This survey is a screening questionnaire to see if you qualify to participate in the study. Would you be willing to fill out a few questions to see if you qualify? This should take less than 5 minutes. All answers and any contact information provided will kept confidential. Your responses to this screener will not be linked to your responses on the main survey. Data for ineligible participants will be stored anonymously and will be used to describe the number of eligible and ineligible participants and reasons for ineligibility.

Please feel free to email the study investigators at **MindfulnessPAStudy.asu@gmail.com** with any questions regarding this study.

Q2 Are you an undergraduate student at Arizona State University?

- ○ Yes (1)
- ○ No (2)

Skip To: Q3 If Are you an undergraduate student at Arizona State University? = Yes
Skip To: Q17 If Are you an undergraduate student at Arizona State University? = No

Q3 Are you currently enrolled in courses at Arizona State University (online or in-person)?

- ○ Yes (1)
- ○ No (2)

Skip To: Q4 If Are you currently enrolled in courses at Arizona State University (online or in-person)? = Yes

Skip To: Q17 If Are you currently enrolled in courses at Arizona State University (online or in-person)? = No

Q4 What is your age?

_____

Skip To: Q17 If What is your age? > 24

Skip To: Q17 If What is your age? < 18

Q5 Has your doctor ever said that you have a heart condition OR high blood pressure?

- Yes (1)
- No (2)

Skip To: Q17 If Has your doctor ever said that you have a heart condition OR high blood pressure? = Yes

Skip To: Q6 If Has your doctor ever said that you have a heart condition OR high blood pressure? = No

Q6 Do you feel pain in your chest at rest, during your daily activities, OR when you do physical activity.

- Yes (1)
- No (2)

Skip To: Q17 If Do you feel pain in your chest at rest, during your daily activities, OR when you do physical act... = Yes

Skip To: Q7 If Do you feel pain in your chest at rest, during your daily activities, OR when you do physical act... = No

Q7 Do you lose balance because of dizziness, OR have you lost consciousness in the last 12 months?

- Yes (1)
- No (2)

Skip To: Q17 If Do you lose balance because of dizziness, OR have you lost consciousness in the last 12 months? = Yes

Skip To: Q8 If Do you lose balance because of dizziness, OR have you lost consciousness in the last 12 months? = No

Q8 Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?

- ○ Yes (1)
- ○ No (2)

Skip To: Q17 If Have you ever been diagnosed with another chronic medical condition (other than heart disease or... = Yes

Skip To: Q9 If Have you ever been diagnosed with another chronic medical condition (other than heart disease or... = No

Q9 Are you currently taking prescribed medications for a chronic medical condition?

- ○ Yes (1)
- ○ No (2)

Skip To: Q17 If Are you currently taking prescribed medications for a chronic medical condition? = Yes

Skip To: Q10 If Are you currently taking prescribed medications for a chronic medical condition? = No

Q10 Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active?

- ○ Yes (1)
- ○ No (2)

Skip To: Q17 If Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (musc... = Yes

Skip To: Q11 If Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (musc... = No

Q11 Has your doctor ever said that you should only do medically supervised physical activity?

- ○ Yes (1)
- ○ No (2)

Skip To: Q12 If Has your doctor ever said that you should only do medically supervised physical activity? = No

Skip To: Q17 If Has your doctor ever said that you should only do medically supervised physical activity? = Yes

Q12 Congratulations you are eligible to participate in this study. We anticipate this study will take 30-45 minutes to complete. Do you have the available time to complete this survey at this time?

- ○ Yes (1)
- ○ No (2)

Skip To: Q14 If Congratulations you are eligible to participate in this study. We anticipate this study will take... = No

Skip To: Q13 If Congratulations you are eligible to participate in this study. We anticipate this study will take... = Yes

Q13
Please click on this link and you will be directed to the study survey: [LINK TO BE INSERTED AT A LATER DATE]

Upon completion of the survey associated with this link, you may be eligible to receive a $10 gift card for Amazon.

Q14 If you would like to participate, please provide us with your email address so we can send you a link to the survey. You will be able to access the survey via the link and complete it at your convenience.

_____

Skip To: End of Survey If If you would like to participate, please provide us with your email address so we can send you a... Is Not Empty

Q17 We appreciate your interest in participating in this study. Unfortunately, you do not qualify as a participant at this time. We thank you for your time.

End of Block: Mindfulness and Physical Activity Screener

APPENDIX E

STUDY QUESTIONNAIRE

Mindfulness and Physical Activity Questionnaire

Start of Block: Informed Consent

Q1.1
My name is Vinson Napolitano, I am a graduate student under the direction of Associate Professor, Cheryl Der Ananian, in the Exercise Science and Health Promotion Program, College of Health Solutions at Arizona State University. I am conducting a research study to examine the relationships between mindfulness, physical activity, stress, intention to participate in exercise, and motivation to exercise in undergraduate students at Arizona State University.
I am inviting your participation in this study because you have met the eligibility requirements to be part of this study. You will be asked to complete series of online surveys that are anticipated take around 30 minutes to complete. Once the survey is completed and submitted your obligation to the research will be complete. You have the right not to answer any question, and to stop participation at any time.
Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You may be eligible to receive a $10 e-gift card from Amazon.com for completing the survey; the first 150 people to complete the survey will be eligible to receive an e-gift card. At the end of the survey you will have the option to provide information for the sole purpose of receiving your incentive. If you do not want to provide this information via questionnaire, an email address to contact the study directly will be provided. The e-gift card will be emailed to the address provided. All information collected will be removed from the data file once the electronic gift card has been sent and will not be used for any purpose other than sending gift-cards. You must be 18 to 24 years old and an undergraduate student at Arizona State University to participate in the study.
There is no direct benefit to you for your participation in this study. There are no foreseeable risks or discomforts to your participation.
All responses will be confidential. The IP address collection option has been turned off in the survey software as an extra layer of protection. Survey results will be stored in a secure electronic file on a secured computer in the Arizona Biomedical Center at Arizona State University. Only the researchers directly involved in this study will have access to the files. The results of this study may be used in reports, presentations, or publications but individual names will not be used. In any sort of report we make public, all reports will be shared in the aggregate form. If you have any questions concerning the research study, please contact the research team at: Vinson Napolitano at vnapolit@asu.edu, or Cheryl Der Ananian at Cheryld@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU

Office of Research Integrity and Assurance, at (480) 965-6788.

By completing the survey, you agree to participate in the study. If you do not want to participate, please exit the survey now.

[ASU IRB# STUDY00009603 Approval Period 2/13/2019]

End of Block: Informed Consent

Start of Block: Demographics

Q2.1 What is your age?

- 18
- 19
- 20
- 21
- 22
- 23
- 24

Q2.2 What is your gender?

- Male
- Female
- Other
- Prefer not to answer

Q2.3 Are you of Hispanic, Latino, or Spanish origin?

- ○ Yes
- ○ No
- ○ Prefer not to answer

Q2.4 How would you describe yourself?

- ○ American Indian or Alaska Native
- ○ Asian
- ○ Black or African American
- ○ Native Hawaiian or Other Pacific Islander
- ○ White
- ○ Other
- ○ Prefer not to answer

Q2.5 What academic year are you in college?

- ○ First Year
- ○ Sophmore
- ○ Junior
- ○ Senior
- ○ Post-bac

Q2.6 What is your major? (Please type out full name of degree. For example, EXW is Exercise and Wellness)

_____

X→ X→

Q2.7 What is the main campus that you attend?

- ○ Tempe
- ○ Downtown Phoenix
- ○ West
- ○ Polytechnic
- ○ Lake Havasu
- ○ Exclusively Online

Q2.8 Where do you currently live?

- ASU Residence Hall/Dormitory
- ASU Fraternity or Sorority Housing
- Off campus, with parents or family
- Off campus, with roommates
- Off campus, live alone
- Other

Q2.9 If you answered "Other" for the previous question, where do you currently live?

_____

Q2.10 What is your employment status?

- Full-time
- Part-time
- Volunteer
- Non-employed

Q2.11 Do you regularly practice meditation?

- Yes
- No

Q2.12 What type of meditation do you practice?

- ○ Sitting Meditation
- ○ Moving Meditation (e.g. tai chi, yoga, etc.)
- ○ Both
- ○ Other

Q2.13 If you selected "Other" in the previous question, what type of meditation do you practice?

_____

Q2.14 Did you participate in structured physical activity (e.g. team sports, individual sports, dance, cheer, etc.) in high school?

- ○ Yes
- ○ No

End of Block: Demographics

Start of Block: Mindful Attention and Awareness Scale

Q3.1 Instructions:
Below is a collection of statements about your everyday experience. Using the scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

	Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
I could be experiencing some emotion and not be conscious of it until sometime later.	○	○	○	○	○	○
I break or spill things because of carelessness, not paying attention, or thinking of something else.	○	○	○	○	○	○
I find it difficult to stay focused on what's happening in the present.	○	○	○	○	○	○
I tend to walk quickly to get where I'm going without paying attention to what I	○	○	○	○	○	○

experience along the way.						
I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	○	○	○	○	○	○
I forget a person's name almost as soon as I've been told it for the first time.	○	○	○	○	○	○
It seems I am "running on automatic," without much awareness of what I'm doing.	○	○	○	○	○	○
I rush through activities without being really attentive to them.	○	○	○	○	○	○
I get so focused on the goal I want to achieve that I lose touch with what I'm doing right	○	○	○	○	○	○

now to get there.						
I do jobs or tasks automatically, without being aware of what I'm doing.	○	○	○	○	○	○
I find myself listening to someone with one ear, doing something else at the same time.	○	○	○	○	○	○
I drive places on 'automatic pilot' and then wonder why I went there.	○	○	○	○	○	○
I find myself preoccupied with the future or the past. I find myself doing things without paying attention.	○	○	○	○	○	○
I snack without being aware that I'm eating.	○	○	○	○	○	○

End of Block: Mindful Attention and Awareness Scale

Start of Block: Philadelphia Mindfulness Scale

Q4.1 Instructions: Please indicate how often you experienced each of the following statements within the past week.

	Never	Rarely	Sometimes	Often	Very Often
I am aware of what thoughts are passing through my mind.	○	○	○	○	○
I try to distract myself when I feel unpleasant emotions.	○	○	○	○	○
When talking with other people, I am aware of their facial and body expressions.	○	○	○	○	○
There are aspects of myself I don't want to think about.	○	○	○	○	○
When I shower, I am aware of how the water is running over my body.	○	○	○	○	○
I try to stay busy to keep thoughts or feelings from coming to mind.	○	○	○	○	○

When I am startled, I notice what is going on inside my body.	○	○	○	○	○
I wish I could control my emotions more easily.	○	○	○	○	○
When I walk outside, I am aware of smells or how the air feels against my face.	○	○	○	○	○
I tell myself that I shouldn't have certain thoughts.	○	○	○	○	○
When someone asks how I am feeling, I can identify my emotions easily.	○	○	○	○	○
There are things I try not to think about.	○	○	○	○	○
I am aware of thoughts I'm having when my mood changes.	○	○	○	○	○

I tell myself that I shouldn't feel sad.	○	○	○	○	○
I notice changes inside my body, like my heart beating faster or my muscles getting tense.	○	○	○	○	○
If there is something I don't want to think about, I'll try many things to get it out of my mind.	○	○	○	○	○
Whenever my emotions change, I am conscious of them immediately.	○	○	○	○	○
I try to put my problems out of mind.	○	○	○	○	○
When talking with other people, I am aware of the emotions I am experiencing.	○	○	○	○	○
When I have a bad memory, I try	○	○	○	○	○

to distract myself to make it go away.	

End of Block: Philadelphia Mindfulness Scale

Start of Block: Exercise Regulations Questionnaire (BREQ-2)

Q5.1 Why do you engage in exercise? We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

	Not true for me	-	Sometimes true for me	-	Very true for me
I exercise because other people say I should	○	○	○	○	○
I feel guilty when I don't exercise	○	○	○	○	○
I value the benefits of exercise	○	○	○	○	○
I exercise because it's fun	○	○	○	○	○
I don't see why I should have to exercise	○	○	○	○	○
I take part in exercise because my friends/family/partner say I should	○	○	○	○	○
I feel ashamed when I miss and exercise session	○	○	○	○	○
It's important to me to exercise regularly	○	○	○	○	○
I can't see why I should bother exercising	○	○	○	○	○
I enjoy my exercise sessions	○	○	○	○	○
I exercise because others will not be	○	○	○	○	○

pleased with me if I don't					
I don't see the point in exercising	○	○	○	○	○
I feel like a failure when I haven't exercised in a while	○	○	○	○	○
I think it is important to make the effort to exercise regularly	○	○	○	○	○
I find exercise a pleasurable activity	○	○	○	○	○
I feel under pressure from my friends/family to exercise	○	○	○	○	○
I get restless if I don't exercise regularly	○	○	○	○	○
I get pleasure and satisfaction from participating in exercise	○	○	○	○	○
I think exercising is a waste of time	○	○	○	○	○

End of Block: Exercise Regulations Questionnaire (BREQ-2)

Start of Block: Exercise Intention

Q6.1 The next three questions will ask about your intention to exercise. There are no incorrect responses.

Q6.2 On a scale of 1 through 7, please indicate your exercise goals. Options range from "1 - Not at all, to "7 - All the time."

	1	2	3	4	5	6	7
My goal is to exercise...	○	○	○	○	○	○	○

Q6.3 On a scale of 1 through 7, please indicate your response to the following statement:

	1	2	3	4	5	6	7
I intend to exercise at least every other day.	○	○	○	○	○	○	○

Q6.4 Please answer the following statement: "I plan to exercise and average of _____ times per week."

○ Times per week _____

End of Block: Exercise Intention

Start of Block: Perceived Stress Scale

Q7.1 The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
In the last month, how often have you been upset because of something that happened unexpectedly?	○	○	○	○	○
In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
In the last month, how often have you felt confident about your	○	○	○	○	○

ability to handle your personal problems?					
In the last month, how often have you felt that things were going your way?	○	○	○	○	○
In the last month, how often have you found that you could not cope with all the things that you had to do?	○	○	○	○	○
In the last month, how often have you been able to control irritations in your life?	○	○	○	○	○
In the last month, how often have you felt that you were on top of things?	○	○	○	○	○
In the last month, how often have you been angered because of things that	○	○	○	○	○

were outside of your control?					
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

End of Block: Perceived Stress Scale

Start of Block: Physical Activity Questions (IPAQ-LF)

Q8.1 We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

Q8.2
TRANSPORTATION PHYSICAL ACTIVITY:
The next four questions are about how you traveled from place to place, including to places like work, school, stores, movies, and so on. Now think only about the **bicycling** and **walking** you might have done to travel to and from work, school, to do errands, or to go from place to place.

Q8.3 During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

- ○ No bicycling from place to place
- ○ 1 day per week
- ○ 2 days per week
- ○ 3 days per week
- ○ 4 days per week
- ○ 5 days per week
- ○ 6 days per week
- ○ 7 days per week

Q8.4 How much time did you usually spend on one of those days to **bicycle** from place to place?

Please put number of hours in the hours category and number of minutes in the minutes category. For example: if you exercised three and a half hours, enter "3" into the hours category and "30" in the minutes category.

- ○ Hours per day _____
- ○ Minutes per day _____

Q8.5 During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

- ○ No walking from place to place
- ○ 1 day per week
- ○ 2 days per week
- ○ 3 days per week
- ○ 4 days per week
- ○ 5 days per week
- ○ 6 days per week
- ○ 7 days per week

Q8.6 How much time did you usually spend on one of those days **walking** from place to place?

Please put full hours in the hours category and full minutes in the minutes category. For example: if you exercised three and a half hours, enter "3" into the hours category and "30" in the minutes category.

- ○ Hours per day _____
- ○ Minutes per day _____

Q8.7 RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY This section is about all the physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

X→ X→

Q8.8 Not counting any walking you have already mentioned (or work related walking), during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

- ○ No walking in leisure time
- ○ 1 day per week
- ○ 2 days per week
- ○ 3 days per week
- ○ 4 days per week
- ○ 5 days per week
- ○ 6 days per week
- ○ 7 days per week

Q8.9 How much time did you usually spend on one of those days **walking** in your leisure time?

Please put full hours in the hours category and full minutes in the minutes category. For example: if you exercised three and a half hours, enter "3" into the hours category and "30" in the minutes category.

- ○ Hours per day _____
- ○ Minutes per day _____

X→ X→

Q8.10 Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

- ○ No vigorous activity in leisure time
- ○ 1 day per week
- ○ 2 days per week
- ○ 3 days per week
- ○ 4 days per week
- ○ 5 days per week
- ○ 6 days per week
- ○ 7 days per week

Q8.11 How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

Please put full hours in the hours category and full minutes in the minutes category. For example: if you exercised three and a half hours, enter "3" into the hours category and "30" in the minutes category.

- ○ Hours per day _____
- ○ Minutes per day _____

X→ X→

Q8.12 Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

- ○ No moderate activity in leisure time
- ○ 1 day per week
- ○ 2 days per week
- ○ 3 days per week
- ○ 4 days per week
- ○ 5 days per week
- ○ 6 days per week
- ○ 7 days per week

Q8.13 How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

Please put full hours in the hours category and full minutes in the minutes category. For example: if you exercised three and a half hours, enter "3" into the hours category and "30" in the minutes category.

- ○ Hours per day _____
- ○ Minutes per day _____

Q8.14 TIME SPENT SITTING The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

Q8.15 During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

- ○ Hours per day _____
- ○ Minutes per day _____

Q8.16 During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

- ○ Hours per day _____
- ○ Minutes per day _____

End of Block: Physical Activity Questions (IPAQ-LF)

Start of Block: Block 8

Q9.1
[Thank you for your participation in this study, please be aware that we have hit 150 participants and our funding is now complete. As a result, we are no longer able to offer more gift cards to eligible participants.]

Thank you for your participation in this study, you may now exit the survey.

Q9.2 Email you would like to receive the gift card at:

- ○ Email address _____

Q9.3 Are you a United States citizen?

(This information will only be used for gift card tracking purposes and will be kept confidential.)

- ○ Yes
- ○ No

End of Block: Block 8

APPENDIX F

APPROVAL OF FUNDING LETTER

Vinson Napolitano <vnapolit@asu.edu>

Research Grant Program (2018-2019)

ZoomGrants Notices <Notices@zoomgrants.com> Tue, Feb 5, 2019 at 7:54 PM
Reply-To: sherry.39@osu.edu
To: vnapolit@asu.edu

Research Grant Program (2018-2019)

https://graduate.asu.edu/business-services#tabs-0-content_main-3

gpsa.research@gmail.com

gpsa.research@gmail.com

grad-gpsa@asu.edu

GRSP Awardee Information(1).pdf
1497K